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REPORT ON GEOLOGY AND MINERALOGY OF NORTHERN TERRITORY.

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REPORT of REV. J. E. TENISON WOODS on GEOLOGY and MINERALOGY of NORTHERN TERRITORY.

Palmerston, October 7th, 1886.

Sir—I have the honor to report that I have completed my examination of the geology and mineralogy of portions of the Northern Territory, and the following report is the result of that examination:—

Acting upon your instructions, I proceeded to Burrundie, and then, accompanied by Mr. Nash, the Chief Warden, examined all the places where mining had been or was actually being carried on. In the course of these journeys most of the intervening country was prospected, and the geology noted.

After having seen all the mining country, I started in company with Mr. Surveyor Hingston, Mr. Nash, and two men and twelve horses, for an exploration in the less known portions of the interior. Our course was from Mount Wells to Mount Douglas, and thence south-eastward across the ranges to the Evelyn mine. From thence we traced the River Mary to its sources, and then, having crossed a small patch of tableland, reached the upper waters of the Katherine, which we followed down to the telegraph station; from thence we proceeded along the line to Pine creek. Had time permitted it, I should have continued my prospecting tour as far as the Daly river, by crossing the intervening country from the head waters of the Driffield, but this I was reluctantly obliged to leave, as the season was so far advanced. I returned to Palmerston by the overland route from Southport.

Herewith are the results of these geological explorations. It will be observed that in many respects I differ from Professor Tate, but in justice to that gentleman it should be borne in mind that, to use his own expression, his trip was no more than “a reconnaissance in the saddle,” made at a season when detailed examination was impossible. The time at my disposal and the season gave every facility for entering into matters of geological detail. I have in this report dealt with the general conclusions as far as the detail warrants, and I must record here my complete satisfaction at the result of the prospecting tour. I confidently assert that the Northern Territory is exceptionally rich in minerals, only a small portion of which has been made known to the public. I do not believe that the same quantity of mineral, veins of gold, silver, tin, copper, and lead, will be found in any equal area in Australia. In fact, I doubt if many provinces will be found in any country so singularly and exceptionally favored as Arnheim’s Land is in respect to mineral riches. Of the mines that have already been worked, in gold especially, they cannot be said to have gone to any depth, but all nearly have shown unusually good ore, and it is unquestionable that not 25 per cent. of the veins visible have ever been worked at all. As to the causes of this and the depression in the mining interest in the Territory generally, the report will give ample details, but it is from no want of mineral deposits. Years will not exhaust the discoveries to be made here when the difficulties of labor have been got over as they will be surely ere long. The Peninsula of Arnheim’s Land will become one of the great mining centres of Australia.

It only remains, Sir, to thank the Government Resident for the steady co-operation he has given to me in this examination. The idea originated with him, and it was entirely at his request I undertook it, and I trust it has been carried out in keeping with his earnest and active desires for the welfare of the Northern Territory. Allow me also to thank Messrs. Nash and Hingston for their uniform zeal and courtesy in carrying out the survey—of Mr. Hingston’s services as a surveyor and explorer I cannot speak too highly.

PHYSICAL GEOGRAPHY.

Before proceeding to give details of the geology of the Territory, it will be necessary to correct an erroneous idea which has prevailed as to the physical structure of this part of the continent. That idea has been that the mineral area, after rising by an easy slope to the southward, reaches points at varying distances where it is covered by a rampart of sandstone about 600ft. in height. This rampart is supposed to be the edge of the great plateau of an interior or continental Australia. In other places the tableland is supposed to be 800ft. in height above the plains, and 1,800ft. above the sea. Latterly the plateau has been called by the name of the Desert Sandstone, and is supposed to cover over most of the older formations, and to block out, as it were, all the older and mineral deposits.

Whether it does so or not in the far interior I cannot say, though I am inclined to think not. Where I have been there is no such thing as a continuous tableland. Patches of broken tableland occur frequently at the sources of rivers and creeks, but they are only patches—often no more than ridges, and if more than four or five miles in width they descend as an inclined plain to the valley of the next large watercourse, where the older formations generally crop out. Their height varies between 120ft. and 300ft. Once only have I seen a plateau of 370ft. in height at its northern edge, which is always broken. It was less than half

half that elevation Leichardt is said to have found on his descent from a plateau, precipices 800ft. high, but this is now known to be an error in transcribing his notes. The name of "desert sandstone" is unfortunately chosen for these tablelands or flat-topped ridges. Sandstone there is in abundance, besides ferruginous sandstones and sandstone conglomerates, but they are not always in the cliffs, or only form a portion of them. Nearly all the cliffs are capped with compact magnesite, or carbonate of magnesia, from 10ft to 40ft. in thickness, sometimes ferruginous, or quite pure and white. The cliffs are made up of various formations, and it is incorrect to call them "desert sandstone". Here are the proofs. At Yam Creek, about two miles south from the telegraph station, the line passes through a gorge, bordered on each side by precipitous cliffs, varying in height from 130ft. to 200ft. The bottom of the valley is 335ft. above the low-water level of the sea. At one place where I ascended the cliffs they were 130ft. high. Of this 90ft. was granite, 10ft. water-worn quartz conglomerate; ferruginous, magnesian sandstone, 16ft.; pure white magnesite, 14ft. Two miles farther the cliffs were 143ft. high; of this, 80ft. were granite, and 50ft. a highly ferruginous sandstone, horizontally stratified.

At the head of the Mary the cliffs were 150ft. high—30ft. of this was a fine-grained white sandstone, formed of wind-blown sand, the grains under the microscope being rounded and abraded like the sands of the Sahara. Above this was 100ft. of pure white magnesite; the valley was composed of paleozoic slates and felsites—a compact mixture of quartz and felspar, without any traces of crystallization. Other instances will be given in the body of this report. At the gorge of Yam creek, the tableland is a mere ridge. At McMinn's bluff (270ft. above the plain) it is an outlier broken up into detached hills. It is the same at Mount Shooohridge. At the head of the Mary the cliffs are about 200ft. high; then there is an inclined plain rising 100ft. higher in six miles; then for four or five miles an inclined plain descends 40ft. a mile until Kekwick's springs, on a tributary of the Katherine, are reached.

Again: on the heads of the Katherine a sandstone tableland was ascended to a height of 250ft., but it was a mere ridge with a valley 50ft. deep on the east side, with large springs of fresh water giving rise to a creek—crossing this led to an inclined plain of four miles, with a fall of about 25ft. to a mile. This brought us to a gully—the head of Mande creek—where we were, in about three miles, almost on the level of the Katherine, and in auriferous country again. It will be seen, therefore, that, as far as I have seen, "the desert sandstone" (so called) is confined to numerous small patches of a newer formation of moderate thickness which does not cover the older rocks to any large extent. Yet this character would not be suspected from its aspect as seen from a distance. I don't wonder in the least at earlier explorers having been led into error with regard to it. When one ascends to the summit of any moderate elevation, the sloping base, white cliffs, and flat summits of these hills are conspicuous objects, and there extends from them level plains of apparently unlimited extent. But none of the hills are high enough to command an extensive view; if they did, other hills would be seen cropping out.

The mistakes which have occurred have been for want of careful measurements, or from giving descriptions from distant views rather than from actual exploration and a close examination of the nature of the rocks. I have also had the advantage of the 125 miles of levels taken for railway purposes. It must be also borne in mind that the magnesian and sandstone formation never rises to the height reached by the paleozoic and metalliferous rocks. Thus Mount Wells (mica slate with tin and copper veins) is about 900ft. above the level of the sea; Springhill gold mine 800ft.; The Union 700ft.; Jansen's 800ft., and so on. None of these heights are ever attained by the flat-topped tableland.

So far, therefore, from much of the auriferous formation being covered by it, from its nature and elevation, that formation is far more likely to crop out above it. From what has been said it appears that the term "desert sandstone" is a misnomer. Whether the formation is the same as that which was described under that name by Mr. Daintree in Queensland is very doubtful. There are here three kinds of rock. (1) A red sandstone composed almost entirely of rounded grains of sand and ferric oxide. The appearance of these grains and the stratification of the rock show a desert origin such as blown sands present. (2) Magnesite and silicate, and ferro silicate of magnesia; this rock is pure white and yellow or mottled and fiery red. These rocks I believe to be derived from the decomposition of fine volcanic ash, containing much olivine or otherwise rich in magnesia. South of the Edith river there is a large volcanic area with high basaltic hills and much vesicular lava, all rich in olivine. When these volcanoes were in activity (in miocene times), the fine dust from the ashes covered a large area. Thus we find these flat-topped cliffs of magnesite lying on granite rocks on slates (Mount Shooohridge) and sandstone. (3) The third formation, included under the name of "desert sandstone," is a fluvatile conglomerate. It is only found on the banks of streams. It is an extremely hard sandstone horizontally stratified and cross-bedded with the finer laminations marked by black specular iron. It contains much rounded and waterworn quartz gravel from the size of a small pebble to that of a man's head. This formation is much broken into immense boulders and rocks of most fantastic shape. It is very hard, but being full of cracks and fissures weathers easily and gives rise to a surprisingly rough country, almost inaccessible to explorers. It is composed of sandbanks and river boulders, which have hardened since the rivers cut through them. Like the banks of the rivers of the present day, they rise occasionally 100ft. to 300ft. above the bed, and extend two or three miles on either side. Mount Douglas is an instance of this formation, and in the ranges on the upper Katherine river it is developed to a large extent.

The above description of the tablelands and other formation will help much to understand the physical structure of the Northern Territory, which is as follows:—The coast is very low and flat, and rises by a gentle incline at the rate of about 5ft. a mile; but there are low ridges of quartzite, slate, and sandstone rising almost from the sea-level to a height of 50ft. or more, gradually increasing to 100ft. They run north and south, that is generally speaking, with a general trend to the eastward. As they are traced to the south, from these ridges small creeks and tributaries take their rise, and descend towards the main valleys, in which there are permanent waters.

The following heights and distances will give a better idea than any description:—The Elizabeth, distance from Palmerston 25 miles 15 chains, height above sea 52·56ft.; the Berry, distance 35 miles 70 chains, height 76·84ft.; the Darwin, distance 43 miles 45 chains, height 93ft.; the Finnis, distance 54 miles 50 chains, height 184ft.; the Stapleton, distance 69 miles 64 chains, height 236·50ft.; Peter's creek, distance 74 miles 40 chains, height 188ft.; the Adelaide, distance 76 miles 50 chains, height 183ft.; Burrell's creek, distance 80 miles 12 chains, height 177·50ft.; Calder's creek, distance 83 miles 36 chains, height 199ft.; Bridge creek, distance 94 miles 59 chains, height 322·50ft.; the Howley, distance 99 miles, height

height 250-50ft.; Yam creek, distance 111 miles 69 chains, height 328ft.; the Margaret, distance 114 miles, height 340ft.; Foelsche's creek, distance 122 miles 66 chains, height 318ft.; the McKinlay, distance 124 miles 68 chains, height 304ft.; Suadden's creek, distance 131 miles 10 chains, height 404-50ft.; Lady Alice creek, distance 135 miles, height 484ft.; Pine creek, distance 145 miles 79 chains, height 657ft. The distances are by the railway line, and the heights above low-water sea-level at the railway crossings of the various streams.

It will be seen that the heights begin to increase rapidly from the ninety-fifth mile, and continue to Pine creek; so that, though the average rise is about 5ft. per mile, it is less than 3ft. per mile for the first 100 miles, and more than 6ft. per mile for the next fifty miles. This is owing to the commencement of ranges which are connected with most of the mineral country in the Territory. These ranges are a series of parallel ridges, having a south-south-easterly trend, and rising to a height of from 200ft. to 600ft. in height above the plains, though the latter height is exceptional. This mountainous area is about twenty miles in width, and from east to west; and 40 in length, from north to south. In it are contained the sources of most of the small tributaries of the Adelaide and Mary, which are rivers with a north and south direction. The Adelaide may be said to take its rise in the midst of this chain, and the Mary to the eastward and southward. The ridges and ranges are separated in their northern portions by somewhat wide alluvial flats or valleys; but to the south-east the ranges are closer together, higher, and more abrupt, besides being exceedingly stony and barren. Thus the country south-east from Mount Wells, as far as the Mary river, is exceedingly rugged, and many of the ranges and valleys almost inaccessible. The most closely-metalled road would not be more deeply and thickly covered with stones than these valleys and ranges.

Several long and high spurs (500ft. above the plain) are continued to the eastward into the valley of the Mary river, but at about 100 miles from Southport the ranges decline to the level of the plain. At the sources of the Mary the river takes its rise amid flat-topped cliffs of the most picturesque description. The view along the stony white gorges has few parallels in Australia. The valley of the river is hemmed in by straight cliffs or castellated outliers, some 150ft. or 200ft. high. There is often a slope or talus at the bottom, but they are only accessible in a few places. But the valley is for the most part fertile, and shaded by fine graceful palm trees; springs bubble out from the shady thickets at the foot of the cliffs, giving rise to streams many feet wide and deep at a short distance from the sources. The valley is strewn to a bewildering extent with high boulders and masses of rock, which have fallen down from above, because the magnesite is very brittle, with a foundation of loose and friable sandstone. Thus no very long time would be required for the springs to crumble and break away the edge of the tableland, or scoop away the valleys as we see them now. These springs, therefore, I believe to be the origin of the cliffs and gorges at the heads, not only of the Mary, but of the west and south Alligator rivers, and many besides. The magnesite and sandstone strata are very permeable to water. The heavy rainfall of the wet season easily drains through the strata, and bubbles out at the base where it has weathered and broken away the stone into abrupt precipitous and fortress-like hills.

Beyond the Mary, to the eastward, there is tableland, probably partially composed of the sandstone fluvial conglomerates of the west and south Alligator rivers. To the west of the chain of ranges there is a small area of flat-topped ranges, granitic at the base and capped with horizontal strata of sandstone and magnesite. To the westward of this it is said that the metalliferous rocks crop out again, but I have not visited this area. It is evident that it cannot be either important or extensive as a mountain region, as from it no stream of any magnitude takes its rise.

At the Daly river we have an outcrop of the metalliferous country with copper mines of unusual richness. To the south of Pine creek there is a change in the features of the country. Hitherto all the drainage is to the north, and the sources of the waters are the high lands of the metalliferous ranges and the springs at the foot of the tableland; but about 150 miles from Palmerston (railway distances) a watershed is crossed not higher than 800ft. above low-water sea level. Beyond this point the streams have a southern and westerly direction, until the Katherine river is reached, whose bed is about 100ft. above the Mary. Ultimately this large river has a north-west direction, and enters the sea as the Daly river. Thus there is a well defined mountain system, comprising the ranges in which the principal mines are found. It is an isolated system, whose culminating points are Mount Wells on the north, and the country between the Union mines and the Mary river on the south. It is cut off to the north by the river Finiss, which has a generally north-westerly trend, and whose coast outlet is unknown. No part of the ranges seems to be over 1,000ft. above the sea.

GEOLOGY.

The whole of the geology of the Northern Territory is of a simple kind. The formations are few in number. There are no fossils, and the exposed sections are numerous and clear. The most conspicuous, as well as the most common, is mica slate. It is not crystalline, and therefore I do not call it metamorphic. The stratification is frequently perpendicular, but it is inclined at almost every angle. It is jointed into so many lines of fracture that it falls to small angular pieces when quarried. This has been from pressure, and this, combined with the way in which the strata are crumpled and folded, makes it probable that we have in this formation a series of anticlinal and synclinal folds, as if the horizontal strata were crushed together by lateral pressure. Nearly all the upper curves have been subsequently removed by denudation. The rock is in places highly ferruginous, and also contains large portions of magnesia, occasionally chlorite and mica. The latter is very common in the mineral form of muscovite. Near mineral lodes, and near these only, it becomes exceedingly large and abundant. At Tale Head, Port Darwin, the brilliant show of mica which there occurs marks the occurrence of five or six mineral lodes; also at Snadden's creek, McKiulay mine, and Mount Shoobridge. The whole of this formation is paleozoic, and probably, from its mineral character, of the same age as the auriferous slates and schists of Victoria, New South Wales, &c. In those colonies it is called "lower silurian," but, in justice to Professor Sedgwick, should be named "upper Cambrian," or (as proposed as a compromise) "Ordovician." There are no fossils to verify this identification. Plant impressions are certainly found in the slates at Pine creek, but they cannot be identified as yet; but the whole character of the formation is such as to leave little doubt on the mind of the geologist as to the identity in age with the auriferous deposits elsewhere.

Dykes.—In every part of these deposits there are dykes, mineral lodes, and faults. Near Port Darwin camp there has been a considerable overflow of ancient lava, which now consists of a few hills of diorite, a volcanic rock of deep blackish-green color and waxy lustre. It consists of crystals of hornblende, mixed with

felspar,

felspar, triclinic in small quantities. Until more carefully examined the rock at Port Darwin camp may be called "diorite." There are also diorite dykes in many places, especially where the gold has been abundant, such as at Margaret creek and other places. In addition, the country is interlaced in abundance with dykes or veins of a greyish-blue flaggy rock of volcanic character and extraordinary hardness.

These dykes are narrow and of great length—sometimes several miles. Throughout their course they stand out like flagstones, often 10ft. above the ground. The stone is fine grained, and not vesicular. It resembles phonolite, but I must defer any decision as to its character until I have had sections examined. What are the relations of these dykes to the auriferous rocks is hard to say, but they always accompany them. That diorite dykes are accompanied with singularly rich shoots of gold, is what experience throughout the colonies has borne out. These dykes of phonolite (?) appear to be more modern. There are many instances where they accompany a white barren quartz. Probably they are not connected with gold in one way or the other. The quartz veins generally, though not always, run along the summits of the ranges, as their existence has preserved the ridge from decay. This gives rise to a peculiar aspect to the hills, which are a series of sharp ridges, with saddles between. Of course the quartz lodes run parallel with the hills, as they are in fact the nucleus of the ranges.

The strata around the reefs are frequently metamorphosed for a short distance. At the Eleanor mine, Pine creek, the casing is crystalline with crystals of staurolite. At the McKiulay mine the walls are pink granite and much mica. At Springhill mine the ground is faulted in successive steps as it were. At the Eleanor reef the country is mixed up, crushed, and faulted, in much confusion, yet not sufficient to prevent the lodes being followed. The lodes or quartz reefs vary in their mineral contents. For the most part they are gold veins of the usual character, but they are also mineral lodes of silver, copper, lead, tin, and probably nickel, graphite, iron, and manganese. I have seen no antimony.

The term generally used by the miners for the outcrops of the heads of a vein is a "blow," and the idea of their origin is connected with the action of fire. Whatever may be the origin of veins, it is certain that the burnt red and black appearance is the result of exposure to the action of air and water, which has rusted the iron ores and decomposed the other minerals. For a long time past the miners have had a prejudice against what are called "iron stone blows," or caps of lodes in which there was a great development of peroxides of iron. They have often been tried and found poor in gold, or destitute of it, so that even prospecting them has been generally abandoned. There are a good many throughout the district, and the majority have been untouched. They are the heads of true mineral lodes, the mineral character of which will not be determined until the water-level is reached. Silver, copper, and lead are the principal minerals to be expected in them, with, probably, a little gold. I think they are rich ores, but not suited for ordinary methods of treatment, or the battery appliances in use here. New and patent methods for the separation of the ores will have to be adopted. The experience of the Ravenswood (Queensland) miners will be found of service in the Northern Territory. There is in most respects a close similarity between the two mining districts.

Granite.—The peculiarities of the metals will be dealt with presently. The rest of the geology of the country may be dismissed in a few paragraphs. All round the mining area there is a belt of granite. I infer that it is a complete ring, though I have not traced it in every part. Thus, granite is found on the west side all along the telegraph line, and on the east side all along the valley of the Mary, on the north side from the Fergusson to within four miles of Pine creek, and on the south about the neighborhood of the Finuiss river. On the north-west and south sides of this belt the granite is pink in color, coarse grained with large crystals of orthoclase felspar often two inches and more in length. Usually this coarse kind of granite is termed granite porphyry. On the west side it is partly of this kind, but on the east its place is almost entirely taken by blue, close-grained granite—a valuable stone. On all sides this granite crops up into hills of 100ft. and more in height, but never quite so high as the metalliferous slates.

The existence of this belt of granite round the mineral deposits is of the greatest importance. It is a state of things which all experience has taught to be the most favorable for mineral deposits. Usually the greatest richness is found at the edges of these formations, or rather at the junction of the slates with the eruptive granite, and from what I have seen this locality seems to be no exception. All along the east side of the ranges, or the valley of the Mary river, there is a continuous outcrop of mineral veins almost upon the junction. The Eveleen Silver mine is actually upon the extreme edge of the latter, but the section is not visible, as it is overlaid by a small outlier of ancient limestone. This is one instance, but there are many more which have never been prospected to the north and south along the valley of the Mary.

It would seem as if silver, lead, copper, and tin were the metals developed on the edges of this junction, while gold exists generally throughout the slates. But the district is hardly sufficiently prospected to form safe conclusions. The width of this ring of granite varies as far as it is known. On the south of Pine creek it is at least fifteen miles wide, and in some parts of the valley of the Mary it must be nearly as much, as well as on the north. On the west it is overlaid by sandstone and magnesite rocks. An accurate geological survey of this line of junction would lead to the discovery of many mineral lodes.

As far as I have seen the minerals are found in the slate country only. There are quartz lodes and other lodes in the granite, but they have proved barren as yet. Not that gold and other minerals may not be found in granite, as they are in Charters Towers and in Victoria, but there are few exceptions to the following rule: Where mineral veins pass from one formation to another they change their character. Thus, if they have been rich in slate country and pass into granite, they will become poor and barren, and *vice versa*. When the belt of granite is traversed we find that the metalliferous formation again crops out on the north and south—thus the whole country between Southport and Port Darwin consists of that formation capped here and there with a little magnesite. There are many quartz lodes, and I am of opinion that the outcrop of ironstone in ridges of black nodular limonite marks the locality of mineral lodes. There is every reason to suppose that the junction between the granite and slates on the outside of the granitic ring should be as rich in mineral lodes as the inside line of junction. Mineral lodes, which become barren in passing from one country to another, become metalliferous in returning to the country from which they took their origin. Thus then the edge of the granite country on the outside of the belt to the westward of the telegraph line to the south of the Fergusson and north of the Finuiss should be prospected, and may prove to be rich in minerals.

Limestone.—Next in succession to the granite and the folded and contorted slate strata comes a small outlier of ancient crystalline limestone, which occupies a small area of a few hundred acres at the Eveleen mine. The strata are contorted, and even bent and folded into rude circles. Besides presenting the usual weathered appearance of limestone, of fantastic pinnacles, &c., this formation has a most peculiar aspect from the

the nature of the rock. The area is composed of alternate layers of hard flaggy chert or flint and blue limestone. The latter, of course, weather much quicker than the siliceous rocks, which stand out in ridges and curves like heaps of tiles or fanciful shapes in pottery. This curious feature and the heaps of boulders with which the granite is weathered give the neighborhood of the Eveleen mine a somewhat bold scenery.

In the absence of fossils, no decision can be given as to the age of these beds. They are extremely like the mineral limestones of Queensland. A similar stone occurs as an outlier in the Malay peninsula, Borneo, China, and the Philippines. It is devonian or lower carboniferous, and so, perhaps, is the limestone at the Eveleen. The peculiar way in which the strata alternate with quartzites or chert is exceedingly interesting, and unless deposited in connection with mineral springs is difficult of explanation. The carboniferous limestones of Europe often contain bands and nodules of chert. Under the microscope the limestone is seen to be perfectly crystalline. This metamorphism may be due to the contact of the eruptive granite, or the slow infiltration of water. The mineral lode of the Eveleen has broken through these strata. Therefore the filling in of the silver-lead lodes is of later age than the carboniferous period.

Magnesite and Sandstone.—Above the slates there is a complete absence of any fossiliferous rocks, and almost a complete absence of lime, except in some places on the Katherine river and the Eveleen. The inference, therefore, is strong that there never has been any subsidence into the sea or upheaval from it within what geologists call more recent times.

What we find wherever a good section is exposed is this.—A layer of loose white or red decomposed rock or rubble, some 3ft. or 4ft. thick, lies on the upturned edges of the slates. Above this a layer, some 2ft. thick, of loamy earth, which has been surface soil. Above this is from 14ft. to 120ft. of magnesite or carbonate of magnesia, more or less impure, with silicates of alumina and iron, and mere traces of lime. Not often is it pure white, for the stains of brown, red, and purple, from iron oxide, permeate the whole.

There are also bands and strata, a foot and more in thickness, of yellowish-brown limonite or hydrated peroxide of iron. In many cases it appears to be of the same mineral composition as the slates, and though this is more apparent than real, there is no doubt that they closely approximate in character, but the magnesite is horizontally stratified, is never contorted, it has no uniform dip, but its strata follow the inequalities of the surface on which they rest. The whole rock is essentially a decomposition product; it has not been placed there by the sea, or it would contain some marine remains. I believe it to be a decomposed ash containing olivine, or a fragmentary deposit carried into the air, when the extinct volcanoes of the south (to be referred to presently), broke through the metalliferous slates. The extent and thickness of the deposit need not deter us from this explanation. When in Java, during the eruption of Krakatoa, I have seen deposits of ash several feet in thickness, at more than a hundred miles distance from the volcano.

There is one important fact in connection with these rocks, and that is that the mineral lodes do not crop out above them unless where it is very thin: there is an interesting and instructive section visible at Tale Head, Port Darwin, which shows this. Five or six mineral veins of considerable hardness crop out from the slates which here dip in various directions, at an angle of about 30°. The slates have been eaten away considerably by the action of the sea, so that the lodes stand out like walls. But the magnesite formation covers them on the top. From this we learn that the deposit is one which took place long after the lodes were filled in. I say long after, because the magnesite formation is geologically a modern one. Similar volcanic emanations are clearly of miocene age in Southern Australia; and so I think it is highly probable that they are in this area.

Cretaceous Formation.—I have seen no trace of the cretaceous formation which is so extensively developed in the western plains of Northern Queensland. But in that colony it is reduced by denudation to a few fossiliferous nodules on the summits of the divide—and on the Hodgkinson and Tate rivers. There the slates are of same age and much the same character as the slates here. If, then, the cretaceous sea once covered that area, it is highly probable that it covered this too, though every trace of the formation has been swept away.

Red Sandstone.—As much as 80ft. of highly ferruginous sandstone, horizontally stratified, is found resting on the granite, and even forming small flat-topped hills on the slate hills. Magnesite also covers a few of the slate ridges. The instances are especially about Mount Shoobridge. I believe that these sandstones are of volcanic origin also, but the evidence is too long and too technical to be entered into here. I propose to treat the whole question at an early period in a complete paper on the desert sandstone.

Volcanic Rocks.—About 10 miles north of the Katherine river, on the telegraph line, there is a volcanic area of several hundred square miles. It would take some time to examine it closely and to find what remains there are of the ancient craters from which so much lava has been poured forth. The volcanic hills are rugged and confused, rising to a height of 400ft., and perhaps more. This is insignificant for volcanic peaks, but all the volcanic centres in Australia are of moderate elevation, and when they have been exposed to much weathering mere mounds of dolerites are the result. Here probably the mountains are more rugged. The lavas are vesicular, and in many of the specimens that I have seen every fragment of rock was incrustated with green, glossy crystals of olivine.

I had already concluded that there must be some volcanic centres which had sent forth such quantities of magnesium ash which I found on the ranges, and this olivine rock was a remarkable confirmation of the theory. I do not think that any valuable minerals will be found in connection with this volcanic area.

Porphyry Rocks.—Beyond the sources of the River Mary the metalliferous slates do not reappear south of the magnesite tableland; neither does the granite, but in its place a red porphyry rock of a very barren and arid character. It is a crystalline mixture of quartz and felspar, the crystals being plagioclase and small. This rock rises into small hills of broken and angular character, never weathering into rounded masses like the granite. It is grouped into hills of 200 or 300ft. in height, and forms ranges about the junction of Kekwick's creek with the River Katherine. It also covers the plains with heaps of angular fragments a foot or so in diameter incredibly difficult for horses to travel over.

In a few places we found in this porphyry dykes of basalt, very hard, and like the phonolite already described, except that it does not stand up in slabs. The porphyry occupies a large extent of country always of the most worthless character. It is lightly timbered, covered with coarse, reed-like grasses of the dry country. It is utterly destitute of minerals.

Fluviatile Sandstone Conglomerates.—These have already been described. They lie on the banks of the Katherine, covering the porphyry, but a few water-worn fragments of that rock were visible in the conglomerate. The majority of pebbles are white quartz, of which, strange to say, there are no veins in the porphyry rock. This sandstone forms tablelands on both sides of the river, and a mile or two in width for

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some ten miles or so. Then the metalliferous slates reappear with tin and alluvial gold. This is on Maude creek, where gold is reported, but the country does not appear to me to be very promising.

Limestone.—About the telegraph station at the Katherine river the banks form a tableland some 60ft. to 100ft. above the stream. It is covered with an outcrop of grey limestone which has weathered into boulders and pinnales of a very rough character. It forms low ranges about five or six miles from the north bank of the stream. These ranges are very rough, and quite inaccessible to horses.

MINERALS.

Gold.—From what has been already said, it will appear that the gold of this country is found in exactly the same manner as in other parts of the world. It is needless to repeat what these conditions are. The stone in those reefs which have been worked is rich, and would pay well to work in any country but this, where wages and cartage are so enormously high. The gold generally is of high standard. The total amount exported from August, 1880, to September, 1885, is 121,779oz., of the value of £432,959. This, of course, is not by any means a full statement of the gold obtained in the Territory. The amount is large, but divided amid the number of mines worked, and the number of miners employed, it is relatively very large, and shows the richness of the country.

Of two things I am convinced—first, that not one of the mines hitherto worked or abandoned has been exhausted of the gold; secondly, not twenty-five per cent. of the auriferous reefs of the country have been fairly tested. If a prospector does not get a good assay from a bagful of stone, which he digs from the top of the “blow,” the whole is condemned. The test, of course, is utterly insufficient. The chances are much against the prospector striking on the shoot of gold at the first blow of his pick. Who does not know the thousands of instances where rich mines have lain idle for years from bad prospecting? A slight examination convinces one that many of the reefs in the Territory contain rich metal, even though the prospector has turned away from them. The gold in most of the reefs is remarkably clean and pure, with little sulphur or arsenic or other troublesome minerals.

Some mines are an exception, and the sulphurous tailings in them are considerable. It would be well if the miners would follow an important piece of advice, which has reference to tailings. They should be stacked like compost heaps, with equal quantities of leaves, branches, grass, or any decaying vegetable matter. In a couple of years the pyrites will be considerably or completely decomposed, and can be treated in the mill without any roasting. Pyrites heaps are often very rich in gold, and will soon pay for their keep.

It may certainly be said that the quartz reefs of the Northern Territory have never had justice done them by first-class machinery. Indeed, it is stated that the Union reefs have been brought to ruin by the battery employed, which let large quantities of amalgam go down the creek; but with small capital, enormously high wages, and equally high cartage, it could hardly be otherwise. When these shall have been adjusted to the rates of the value of the quartz, then the day of the mines of the Northern Territory will have come. Everything is hoped from the railway to bring this about; there is plenty of material to work upon. I regret being unable to give the proportion of gold produced to the quartz crushed. I believe the average is high, generally over an ounce. Some of the crushings of the top stone have been enormously rich. Thus at the extended Union, in 1877, forty tons of quartz yielded 740 ounces of gold. This is exceptional, and belongs to the returns which miners always expect to obtain from the capping of reefs, where the gold lies, which has weathered out of the stone during countless ages.

In reference to this, I have been asked to give an opinion as to whether deep sinking will give increased returns. For increased returns, I should say that there is nothing peculiar in the ground which would lead one to expect it. In those mines where the shoots of gold have a tendency to form pockets of metal, the ground may become richer at any moment, especially where the quartz lode is intersected by veins of diorite; here rich gold will nearly always be found, and often as much in the diorite as the quartz. All questions connected with deep sinking are best answered by the diamond drill, but seeing how few of the mines are able to pay for an efficient battery, it is hardly to be expected that they could pay for drill exploration. Besides, the question of deep sinking is not important. Just now there is plenty of payable stone within easy reach in most of the mines if labor and cartage were only obtainable at a price commensurate with the value of gold.

In the alluvial workings the conditions are precisely similar to alluvial gold in other parts of the world, the sinking is shallow, sometimes merely surfacing, and the gravel scarcely waterworn; this is the more extraordinary, as the rainfall is much greater here than in Victoria or New South Wales, where the drift gravel is so much rounded, but the elevation is much greater.

The alluvial diggings are generally in shallow valleys with low ridges on each side. Curiously enough, rich gold has been found in valleys where on the ridges forming the valley not a trace of a quartz reef could be found. Finely-divided gold, no doubt, exists to some extent in the slates, and this must be the explanation of fine gold in alluvial far from any reefs, just like stream tin. True stream tin is not derived from reefs or lodes, but from finely disseminated particles of tin in granite. Nuggets are not common, and never of very large size. The very fine gold would appear to be inexhaustible, as the Chinese always seem able to make a living, no matter how often they turn over the old headings.

It only remains to say that, as the reefs containing good gold are far from being all discovered in the Territory, so it is with the alluvial; there are gullies and flats innumerable which have never been even prospected; they are all connected with the auriferous slates, and even with quartz reefs. To name them would be endless, but I especially mention the country between Mount Wells and Mount Douglas, amid the ranges on the east side until the ranges fall away, a distance of between forty and fifty miles.

The fluvial conglomerate is full of quartz boulders—in fact it is a drift derived from quartz lodes. It may be worth while trying whether gold is to be found at the base. I do not expect it, however; these drifts have an ugly resemblance in character to what Mr. Selwyn named the barren miocene alluvial drifts of Victoria, in which gold is never found. It is at present inexplicable why this should be so, and it is very odd that the phenomenon should be repeated in North Australia, but it needs further investigation.

At present all the alluvial diggings, except Bridge Creek, are entirely in the hands of Chinese, and Bridge Creek soon will be. A European who expects £4 10s. to £5 per week, and who gets it here, will find, even on a rich alluvial gold field, a poor field for his labor. While this state of things exists it would take a very rich goldfield indeed to make much change in the prospects of the Northern Territory.

Silver.—All the silver lodes that I have seen in the Territory are silver-lead lodes. Silver is also associated with gold in one or two mines, and with copper. I have seen no horn silver, or any of those ores which make a speciality of the mines of the Silverton lodes. Some of the so-called pyrites from the gold reefs

reefs contain sufficient silver as to rank almost as a silver ore. All the lode silver in the Northern Territory comes from galena. This, as a rule, is very rich in silver. Very large assays are reported from some mines, but without paying too much attention to these rather uncertain kind of statements, it may be asserted that there are few ores from which a bead of silver cannot be obtained with an ordinary blowpipe. The silver-lead veins have been found generally on the edge of the slate, and near the junction with the granite. There are several outcrops of such veins on the west side of the valley of the Mary. Comparatively few have been prospected as yet. There are also excellent shows of galena on the surface, especially at the Eveleen, Robinson's, Barrett's lode near Mount Shoobridge, south of Pine creek, and other places. The amount of silver must be very large to pay the expenses of smelting and carriage, as things are now; but eventually there can be no doubt large productions of silver may be looked for from the Northern Territory.

Lead.—From what has been already said it will be seen that lead lodes are numerous in the Territory. They are always associated with silver; the ores are sulphides and carbonates, and, like the lead ores of Britain, vary very much in the quantity of silver. In England, the lead ores of Devonshire and Cornwall are the richest, Derbyshire very poor, and Shropshire ores are entirely free from silver. In most cases cavities of carbonate of lead (cerusite), besides mimetessite (arsenate of lead) are common, with peculiar crystals of cupro-plumbite, or a mineral compound of oxides of lead and copper.

Tin.—This metal will eventually be one of the great sources of mineral riches in the Territory, especially as it occurs in the form of reef tin, which is so comparatively rare. It may be well to explain that the most of the tin discoveries in Australia have been made in stream tin, which is never of a permanent character. The exceptions are the rich tin vein district in Herberton, Queensland, and probably some places in Tasmania.

Stream Tin is quite a different formation. It is derived, as far as my experience goes, from the weathering of granite rocks at their junction with newer and stratified rocks. It has not been in veins but diffused through the substance of the rock generally in grains and crystals of small size. It is entirely an alluvial formation, and where it exists no lode tin is found. This was the character of the stream-tin mines at Stanthorpe and other places in Queensland, New South Wales, and Victoria. This is universally the character of the tin mines in the Indian Archipelago, many of which I have visited. On the other hand, I know of no case in Australia or the East where stream tin occurs in connection with tin veins. There is always in the watercourses near the lodes a certain amount of rubble tin ore derived from the lodes, but it is of large size and small in quantity. Thus it is in the rich tin-vein district in Queensland, and thus it is in the Northern Territory. I have seen no stream tin, properly speaking, except a little from Maude creek on the south of the Katherine. The rubble tin from Mount Wells, and the splendid specimens of wood tin from Snadden's creek, are derived from the lodes. There is no wash, so to speak, and the supply was very soon exhausted. But the vein tin of the Northern Territory is abundant and rich. It is spread over a wider area than the Herberton mines, and the lodes are more numerous. I am convinced, from what I have seen, that no part of Australia can show tin lodes to the same number and extent, though in particular instances, such as Mount Bischoff in Tasmania, they may be richer. The instances of this will be seen in the detailed descriptions of the mines, such as Mount Wells, the mines on the McKinlay River, Mount Shoobridge, and the Finmiss.

So far the lodes have been found confined to the north and western and southern edges of the metalliferous country. At Mount Wells and the McKinlay mines they are more central. These mines are distinguished by the number of veins, and their being crossed with copper lodes, as in Cornwall. In fact, there is much resemblance between this country (as using the word "country" in the miners' sense) and Cornwall. In the direction of Mount Shoobridge there is a great development of mica (Muscovite), which is always regarded as a favorable sign. At Mount Shoobridge (Cruikshanks' claim) crystals of mica are of very large size, and abundant also at Nash's claim, Solomon's, &c. It would be invidious to single out any mine for special notice, but I may say that all of those I have examined promise well, and some give indications of extreme richness. It may be added that many more lodes will yet be discovered on the edge of the granite country. At Talc lead, Port Darwin, I counted five mineral lodes of some width, probably poor in tin, and at the sea level; but a careful search will develop many more. The Northern Territory may be emphatically pronounced to be a tin country.

Copper.—Lodes of this metal have been found in many places, either alone or in connection with tin and silver-lead lodes. The Daly river copper mines I have not visited, but the ores I have seen are of singular richness. They are apparently abundant as well, and, being situated close to a place of shipment, it has paid so far to send them to Newcastle, New South Wales, for treatment. This promises well, and, should the price of copper rise, as it assuredly must do, the Daly river will be a most important mining district. Moreover, the country is extremely good. Copper is also found at Cruikshank gully, south of Pine creek, at the Howley, and near Port Darwin camp. At Mount Wells there are many small veins intersecting the tin and the McKinlay mines. The Eveleen mine is a lode of copper and galena. The copper ores are poor, but probably contain a proportion of silver. Copper would be found in many other places if prospected for, and it will yet be a valuable mineral in the Northern Territory.

Nickel.—At the Eveleen mine there are several indications of nickel ore. It is also spoken of as having been found at Mount Wells and Snadden's creek.

Iron.—Ores of this metal are found everywhere, but of poor quality. No doubt they would be useful in reducing copper ores, and may be serviceable to the Territory yet.

Manganese, Graphite, and Bismuth are all found in small veins, especially near Mount Wells, the Eveleen, and the Union. The bismuth seen by me was metallic, and of fine quality; but the possessor did not state where it came from.

Gem Stones.—My opportunities for observation were not long enough to investigate in this direction. The indications are hardly favorable, but the most likely places are the basaltic country, ten miles north of the Katherine river.

PROSPECTING RESULTS.

It only remains now to give the result of the prospecting tour and exploration through the southern and eastern portions of the territory. On my arrival at Burradie, rather more than a month was spent in the examination of the mines, whether abandoned or in operation. The details are given in the following pages. The object of this portion of the report is to show that the mines are still good and valuable, and have only failed, where they have failed, from the peculiar circumstances and difficulties of labor and capital.

Mining Districts—Mount Wells.—This mine has a special interest attached to it, not only because it was the first place in the colony from which extensive deposits of ore were reported, but also because of the extraordinary

extraordinary accounts of its richness which have reached the other colonies from time to time. It has been called the Mount Bischoff of Australia; but there is no resemblance between the two mines. The Mount Bischoff is an exceptional deposit of tin ore, not conforming to previous experience in tin mining; Mount Wells, on the contrary, is a tin mine of the usual character, very much resembling the tin mines of Cornwall, both in the country and in the occurrence of ore in the veins. But the tin itself is of excellent quality, surpassing anything ever found in Europe or anywhere, except in Australia. The mine is situated in the best part of the mineral country of the Northern Territory, between Yam creek and the McKinlay river. The whole country between these two points is one large network of quartz reefs, porphyry dykes, and dioritic eruptions. Mount Wells is the culminating point of the ranges, or the highest summit. It is about 600ft. above the plain, and, say, 950ft. above the sea level. It consists of stratified quartzose slates, with a little—very little—mica, not differing much from the rest of the country hereabouts.

But the surprising thing about Mount Wells is the number of tin, and I should say copper, lodes with which it is injected, and all within a comparatively small area. No doubt many of these are mere leaders, and will be found to join the main lodes; but their number is considerable, and they all contain some tin ore. There are two main lodes from which the ore is being taken, and on them a shaft has been sunk and an adit driven below for 100ft. These are only a short distance from the battery. By means of a tramway and an endless wire the crushing stuff can be easily and cheaply brought down, and this work is about to be commenced forthwith. A dam has been constructed close to the engine-house, on a creek which comes from a gully on the side of the mountain. Thus a considerable quantity of water has been stored, but, possibly, not equal to the requirements of the place. But another dam is in course of erection higher up the creek, which will give a very large storage of water. The machinery erected is of a very complete and first-class description, with a sufficient battery, elaborate contrivances for separating the iron ore, of which there is a good deal, and dealing with the tin slime. This is also in working order; but at present nothing can be done for want of water, and this must continue until the rainy season sets in.

In a tunnel driven into the hill on the side of the creek, to catch another lode, there is a small copper lode; but all the sides of this adit have been covered with infiltrations of copper sulphate from the joints of the rock, showing that there must be an extensive vein, or a series of veins, of copper at no great distance. There have been some hitches in the management of this mine, which have led to much delay and expense, and kept the work from giving returns to the shareholders, as it ought reasonably to have been doing by this time. Whatever may be the causes, it is not the fault of the mine. That is good enough if skilfully and economically managed. In character the ore is like that of the Herberton mines, in Queensland. The appearance of some of the stone is very good. Taking them all round, the ores may not yield a high percentage, but then there is a large quantity, and easily accessible. When the railway is opened the Mount Wells mine ought to pay good dividends.

McKinlay Mines.—These mines occur on a range lying about a mile and a half south by west of Burrundie. It is one of the series of detached north and south ridges which cover, in parallel lines, much of the country between the coast and the tableland in the Northern Territory. It is exceedingly steep, very stony, with an uneven outline, rounded into a series of camel-hump elevations. The bed rock crops out in irregular angular fragments, slaty in structure, but not finely fissile. The rock is crystalline, showing mica in minute crystals and quartz in a very hard felspathic paste. In spite of the marked crystalline structure, there are distinct marks of stratification, the strike corresponding with the range, and the dip varying in inclination and direction. Besides the stratification there is a series of joints, five or six in number; two are almost perpendicular to the plane of stratification, one almost parallel with it, and the rest inclined at various angles so as to break the rock into wedge-shaped masses. The color of the rock, where not weathered, is dark blue-black, but where the influence of water and carbonaceous matter has affected it on the surface, it is stained in various shades of red and brown. There are two parallel ridges on this range, the eastern one a third lower, say 400ft. above the plain, and the higher about 600ft., or 1,150ft. and 1,350ft. respectively above the sea-level. These ridges command a good view of the surrounding country, Mount Wells bearing north ten degrees east four miles, with a remarkable conical hill named Piccaninny Mount Wells on the western slope. On both the ridges there are conspicuous outcrops of quartz and ironstone near the summit which, running parallel with the range, show the lines of the lodes.

At the summit of the eastern or lower ridge a few shafts have been sunk, and clearings made on the cap of the lodes. These workings have been made by the Mount Wells (Northern Territory) Tin Mining Company, Limited, who are at present under suspension from working by Government, as I am informed. The company is represented on the ground by Mr. Deane. The mine is commonly known as No. 1 company. The first shaft one meets with is called No. 3. It has been sunk on the lode for 30ft., and, then a drive made for 35ft. This has uncovered the lode about 2ft. wide, with very clean cut parallel walls and a slight northerly dip. Several other leaders were uncovered at the same time, not all tin-bearing. The main lode shows exceedingly well. The tin is in fine crystals in quartz, or disseminated in chlorite of massive character, and little or no iron. Some of the leaders uncovered in this shaft were of mica slate, with aggregations of plumose green mica, probably muscovite. There was also, at No. 3 shaft, hard casing to the lode composed of a pink and green granite of very pretty appearance. The felspar was orange pink orthoclase, and the mica a yellowish green, quartz scanty. The fact of this granite near the lodes is significant, and seems to indicate that a more complete state of metamorphism would convert the whole of the stratified slates into granite. No. 2 shaft, a little further up the hill, is on a different lode. It has been followed for about 60ft., getting good ore right through. Mr. Deane states that picked ore sent to England produces over 50 per cent. of tin of the finest quality. The ore is in chlorite and quartz, but not so much chlorite as in the No. 3 shaft, and more of quartz. On the ridge of this hill there are many quartz reefs cropping out, indicating lodes. No. 1 shaft has been sunk for 70ft. on a 3ft. lode with a casing of pink felspar and mica with chlorite. The stone on the ore heap shows very good tin of high percentage. There are also faint traces of copper in this lode. A peculiar white friable stone on the foot and hanging wall may be found to contain other minerals.

In the gullies leading from these hills prospecting for stream tin has led to good results. There must be a considerable amount of detritus from the reefs, which has collected in the course of ages from the weathering of such steep mountain slopes. A large amount of good ore remains untouched in these localities. At the south-west base of the range whereon the shafts have been sunk, a drive has been made for 100ft. into the hill to catch the lodes above mentioned. This gives a very interesting section, revealing many leaders and some lodes not seen above. It is from this section also that a correct idea may be obtained of the

the stratification, the true mineral character of the rock, and the system of joints. At the further end is a lode of graphite about 8ins. wide; it is the laminated variety, but at this part of the lode of poor quality. It is largely mixed with peroxide of iron so as to give a brownish streak under the microscope; this is seen to contain only a small proportion of graphite particles.

Springhill.—The road between Deane's and Springhill, about six miles, passes over the anticlinal and synclinal folds of a very fissile slates. The low outcrops bristle like spikes on all sides, difficult and dangerous for travellers and of most peculiar appearance. The road also passes along the eastern base of a range 400ft. above the plain. The sides of this ridge are exceedingly steep and covered with loose stones. Half way between the township of Burrundie and Springhill there is a conspicuous outcrop of rock in pale green flags weathering into yellow and red. It is remarkably hard, fine grained, and of a paler green than the diorite of the country, and finely crystalline. This whinstone dyke is stated to be traceable for over forty miles of country, or beyond the Adelaide. It may be described provisionally as a hornblende porphyry.

At Snadden's creek there is an engine and battery of stamps, with buddles, &c., and altogether a complete and very excellent crushing plant. The road from this proceeds westward, and soon ascends the range by a steep path; the mine is on the very summit, 400ft. above the plain. Close by the shaft B 300ft., there is a timber shoot of 400ft. giving a fall of 276ft. for carrying the ore into the valley. The quartz is ferruginous and so are the strata, mottled red and purplish brown, variegated in almost every pattern and color, especially in the joints and stratification lines. The natural color of these slates, however, is a beautiful glossy black, and this is found at moderate depths and a short distance from the lodes. These details are mentioned so that the real nature of the formation may be understood. When not weathered or decomposed it is a fine-grained black slate of excellent quality; it is jointed in five or six systems, lines crossing generally at acute angles; the stratification is always traceable. The lode has been followed for about 300ft. For the first 200ft. there was little difficulty, but then the country became confused and full of faults with much mullock (hydrated iron oxides principally) for 30ft., then another body of stone like the surface was found, only it was faulted 100ft. to the northwards. This stone gradually thinned and ran out at 250ft.; then the country became confused again for 25ft., at which depth another body of stone was found, but again 70ft. or 80ft. to the northwards. They sunk on this for 25ft. and it was 4ft. thick when the work was discontinued. The stone then averaged about 12dwts. of gold to the ton. About 8,000ozs. of gold were taken from this claim. The gold was very fine and worth about £3 17s. 3d. The gullies around have been worked for alluvial gold, where it has a character quite different from the reefs, having been generally found in coarse grains. The range is full of quartz reefs and leaders, none of which have been properly tested at all.

The Clifton mine is a claim close by the Springhill. It has been worked for some short time, and some 600ozs. of gold were got out, but the stone was not rich enough to pay wages and expenses in the Northern Territory. It is a remarkable fact connected with the Springhill mine, though not an exceptional one, that whenever good gold was reached, the strata on each side of the lode were much disturbed, and unless where the strata and joints were disturbed, gold was not found.

Snadden's Creek.—Snadden's creek mine lies a little east of south of Mount Wells, say ten or twelve miles. The road to it, which is very circuitous, runs by succession of low stony ridges with curious drainage hollows in the soil; that is to say that, in places where there is no regular drainage valley, the rain causes pits and hollows which form water holes or the heads of gullies. Outcrops of quartz are met with continually. Where the alluvial has been worked the creek flows across the edges of the strata, which form continual natural barriers of hard blue quartz rock, with much white quartz and crystals of felspar. The stream tin has been caught by these barriers and lies in deep depressions on the upper side. The ore is a coarse tin sand with fragments of beautiful wood tin about an inch or so in diameter; most of this was taken out in the rainy season, and with it is said, some small quantity of gold, but as the miners employed were Chinese, it was stolen. The amount of tin got out from this portion of the mine was sufficient to pay expenses, but there is still a good deal of tin sand visible in the wash. The mine could only be worked in the rainy season as there does not appear to be any favorable site for the storage of water. From the size of the fragments it is evident that the tin ore in the creek came from veins at no great distance, and must be derived from the quartz lodes at each side, which are in the highest degree worthy of further exploration. Many indications and leaders have been found. The only lode which has been at all explored is one on the summit of a low range about a mile from the camp. The ground has been uncovered for a few yards on the cap of the lode. This is a quartz lode lying almost horizontally with excellent specimens of tin on the surface. Indications of nickel ore have been spoken of as occurring in this locality, but the local manager was not able to find the precise spot from which the specimens were taken. They were said to be much like the light green Garnierite of Nounea, New Caledonia.

Yam Creek.—In proceeding northwards from Burrundie to Yam creek, which is distant about twelve miles west, many low but wide ranges of diorite were crossed; the stone is coarsely crystalline, and much the same in character as the diorites of Queensland, notably those about the Gympie diggings. The color is generally a fine dark green, and decomposes into a chocolate soil of excellent quality. No more favorable indication of a mineral country could be had than this outcrop of rock. Some few geologists are inclined to regard this rock as similar to granite, and that it will be found at great depths at the same width or wider than it occurs on the surface. It is more probable that it is a rock of volcanic character, and that when it is found covering wide areas of ground it has overspread them much as lavas do at the present day; if so, these dioritic areas may cover many valuable and extensive mineral deposits. Apart from its mineral indications, the soil is excellent, and the occurrence of the rock may be known by the farms that are always taken out upon it. Yam creek is an extensive mineral or gold-bearing area, including the Margaret, Stuart's, Cement, Neate's, and many other creeks and gullies too numerous to mention. The description of a few may, however, be given. Since silver has taken such an important position in the mineral products of the colonies many reefs and rocks which were passed by with contempt because they did not contain gold are now reprospected with much interest. Thus, an outcrop of dark hæmatite at Grove Hill, which forms a conspicuous rock mass, has been taken up as a silver lode by Messrs. Wilson & Cruikshank, and now has been jumped as a gold mine. The mineral lode is a remarkable one, and eventually will reward its workers in one way or another. At present the only show is hæmatite and carbonate of copper, the latter prevailing; but the sinking is only down 40ft. Here water was reached, but this is merely local; the main water level of this country is probably much deeper. It is stated that some of the stone from this capping produced upon assay as much as 800ozs. to the ton. There are many other outcrops of ironstone visible along the ranges here, which look much like heaps of furnace clinker. No doubt they indicate mineral deposits, probably silver, copper, and some gold. They go by the name of "ironstone blows." The word
blow

blow comes from an erroneous idea that the ferruginous character is due to the action of fire; it is due, however, to the action of water. The prominent character is owing to the hardness of the silicates of iron, which resist the action of weathering. Miners as a rule thought them unworthy of notice, possibly from inability to explore them; they will, however, form a source of permanent mineral riches in the Northern Territory. With no other means of assay than a smith's forge small samples of silver were obtained from another "blow."

Cement Gully.—This is a shallow flat close to Grove Hill. It has low gently sloping ridges at each side, which are covered with broken stone—a quartzite in rather large angular fragments. The sinking was shallow, 10ft. to 12ft. There was much gold taken from this gully, which no doubt was derived from the ranges at each side; yet in these there were no quartz lodes, but only a few unproductive leaders. In such cases the vein from which the gold was derived has been denuded down to where it cut out, and these leaders might indicate where it makes again.

Neates' Gully.—A short marshy flat receiving the drainage of a narrow stony creek. Much alluvial gold was got from this valley. At the top of the ridges at each side there are quartz reefs, and at the head of the valley there is a mine now being worked on tribute by Chinamen. It seems a very good shoot of gold. Though irregular the lode looks excellent with a good show of gold; there are a few scattered crystals of zinc blende, but much well developed crystals of iron sulphide.

Margaret Creek.—The road to these mines leads along the side of the River Margaret, where the land is of excellent quality, chocolate brown and black, derived from the decomposition of diorites and the black carbonaceous alluvial of the creeks. Nearly all of this is under cultivation by the Chinese. Fine crops of maize, sugarcane, sweet potatoes, and culinary vegetables are visible all along the creek, fringed as usual by rugged green lines of bamboo. The diorite from which the soil is derived is an outcrop everywhere. It forms a broad range some 200ft. or so in height, often abutting on outcrop of slate at the bottom of the valley, or even surrounding such outcrops as if it had flowed around it. Its color varies between dark-green, gray, and black. The stone is in no case vesicular; it is entirely crystalline, showing a rock almost entirely composed of hornblende. At the head of the creek, about five miles from Port Darwin camp, there is a network of low quartz ridges, giving rise to many shallow short gullies, where the alluvial has been worked; the sinking was shallow in red earth; about 20ft. or less to the bed rock the soil contained a few angular fragments of rock stratified horizontally. The bedrock was quartzite or felsite of various shades of yellow, red, and brown, with innumerable joints, in which the stratification was not very clear. There were many quartz veins from these leaders to lodes several feet thick. It may be inferred that these are intersected by dykes of diorite, for there were many fragments of this rock on the edges of the claims, but it was impossible to obtain any information on this subject from the Chinese. There were two claims working on a quartz lode, but no crushing mill. It was stated that all the gold obtained was broken out of mullock by hand. Judging by the surface indications there appeared to be a dyke of diorite to the eastward, and then a thick quartz lode. This was said to be poor, presumably because no gold was found when a few stones were cracked on the surface. To the westward was another dioritic dyke at the base of what was called the tableland. Though somewhat resembling the appearance of the desert sandstone, this is probably a highly inclined outcrop of fluvial sandstones, giving rise to precipitous escarpments dipping away from the stream. This goldfield has been entirely mined by Chinese, and most wretchedly mined. It has all the indications of a rich gold country; great quantities of gold have been got out of it, but no one can tell how much, and probably it has nearly all left the country. The district may employ prospectors for a long time to come, and probably has yet to reveal much important mineral wealth to the country. The fact of so many dioritic dykes forming a network as it were with quartz lodes indicate with certainty important mineral deposits.

Grierson's Gully.—A broad flat, with low mammillated hills all round, very stony. It has been worked in shallow sinkings for alluvial gold. The gravel is small, in angular fragments of an inch or less, of blackish quartz rock and schist. Here and there a softer fragment is rounded as if by water, so that the alluvial is probably derived from weak currents. The Chinese work at the heads of the claims, and go cradling them over and over again.

Sandy Creek.—This valley is wide and open, with high, barren, stony ridges on each side, almost destitute of timber. The spurs from the ranges are almost regularly alternate from each side, and these give rise to a series of small gullies, which have all been more or less auriferous. Some of them have proved extremely rich. The ridges from which these gullies descend show quartz lodes, with an occasional conspicuous outcrop of ironstone. It is said that the reefs have been prospected; but this can only have been done in a most superficial and imperfect manner. The whole of the ridges near Sandy creek have a most promising appearance. Diorite dykes are found at the foot of the ridges, and, like them, preserving more or less of meridional direction. It may be some time before capital and enterprise will be brought to bear on these ridges, but most certainly much mineral riches will be found to be contained amongst them. The road along Sandy creek leads to the Yam creek telegraph station, or the Shackle, as it is called. Alluvial sinking has been carried on almost to the doors of the telegraph office. Amid the wash gravel at the heads of the old sinking there are a good many rounded lumps of magnesite (magnesian carbonate), which look like lumps of limestone in the gravel. There is no limestone anywhere near this locality. About two miles south of the Yam creek telegraph-station the overland line passes through what is here termed a gorge, or open valley, bordered on each side by low outliers of tableland. In the bottom of the valley there are outcrops of granite in the form of boulders in many places, and the same rock forms the sloping sides of the valley for 100ft. to 150ft. It is a pink granite with a black mica, and very large crystals of pink and yellowish orthoclase felspar. This formation is capped by red or purple horizontal strata some 50ft. in thickness. The rock is always much weathered and broken into irregular squares, and at a short distance the appearance is that of a ruined wall. In some places the piles of weathered and highly colored stone assume the most fantastic and artificial appearances. This is the so-called desert sandstone, which is supposed to form a continuous plateau over a considerable portion of Australia.

At the place now referred to, the lower stratum lying immediately on the granite is a waterworn conglomerate about 10ft. thick. It is of extraordinary hardness; the stones composing it are completely water worn, and evenly, smoothly rounded. They consist for the most part of red quartz, but there are pebbles of felsite and eucrite. There was no good opportunity for seeing the connection of the granite with this conglomerate, but evidently it did not furnish the materials. Above this is about 35ft. of magnesian rock; it is a compact soft yellowish white rock, with red stains. It consists of silicate of magnesia and carbonate of magnesia, with scarcely a trace of lime, but much iron oxide. On the lower slope there is a little rough carbonate of magnesia lying on the surface, derived from the weathering of the rock above. It is a globular compact

compact earthy magnesite, nearly completely soluble in nitric acid. At the top of this outlier, which was not a plateau, the stone was much broken, but in large masses, with porcupine grass (*Triodia*), and a peculiar gum tree with a fibrous bark called here stringybark (*Eucalyptus acmenoides*), but differing in many particulars from the stringybark of South Australia. This is said to occur only on the sandstone tablelands. At another outlier, two-and-a-half miles to the north-west, the cliffs were of fiery red or purplish red sandstone about 50ft. thick, resting on granite, the junction being about 80ft. above the plain. There was no conglomerate at the base, but the junction was obscured by fallen fragments of rock. The stratification is horizontal, and the joints form a series of lines more or less perpendicular to the plane of stratification. The whole aspect of this formation is very picturesque. Its resemblance to the Hawkesbury sandstones in New South Wales is striking, but it is of deeper red, and there is oblique or cross stratification, or false bedding. Ripple marked slabs are very common, and the grains composing the sandstone are rounded, and covered with a thin pellicle of ferric oxide. But the strange part of this part of the tableland is that these outliers are not 200ft. above the plain, and therefore 200ft. at least lower than the gold mine at Spruighill. Thus the horizon of the metalliferous deposits is considerably above some portions of the sandstone tableland. This is, it will be seen, not uncommon in the Territory.

Attention is also directed to two important facts manifested. One is the thinness of the capping of sandstone on these hills. Next, the stratum of conglomerate of waterworn stones on which it rests. This is not a universal occurrence, but it is very common. Lastly, the sandstone rests on granite in this instance, and in others on the metalliferous slates. Practically, therefore, this leads to the conclusion that the occurrence of desert sandstone is no evidence whatever that it may not be a metalliferous country easily worked, in spite of its capping of sandstone or magnesite.

Brook's Creek, Bergin's Creek, and the John Bull, are alluvial and reef mines which are now in the hands of Chinese. It is impossible to find out from them what they are doing, but a good number of men are employed. The country has a very promising appearance. The field is about six miles south of the Howley, where the indications are all of the best auriferous character. The history of how these fields gradually fell into the hands of Chinese, gives rather a sad instance of what neglect and bad management may do to ruin excellent mining properties. I was informed that the workings at the John Bull were allowed to become flooded in a shamefully careless way, and the mine rendered unworkable because of the limited resources of the proprietors. It may, however, yet be a profitable concern.

The Stapleton.—I did not visit these gold reefs, which are not now working. The stone is said to be good, and when carting and crushing have been cheapened by the railway these mines will be worked again.

Beatson's Mine.—About eight miles a little east of south from the line at the Howley is Beatson's mine, where there is a small quartz-crushing mill erected on a ridge about 150ft. above the Howley river. The intervening country is low quartz ridges, a little over 100ft. above the plain, with slate in the valleys of a hard siliceous character. In all the valleys there have been alluvial workings, and much gold taken out. At the mine itself the slate is a kind of chlorite, with much sulphur and iron pyrites. The water is strongly impregnated with iron, sulphur, and alum. The country is evidently full of other minerals besides gold, showing that the chemical and mineralogical operations of nature have been carried on here on a large scale. Lead, silver, gold, copper, tin, zinc, iron, and manganese have all been found in the country near, besides granite, porphyry, magnesite, kaolin (very excellent; pure white and soft, but with a trace of lime), and tourmaline. At no distant time this will be a great mining district in the north. Beatson's mine is working a lode which has been followed almost perpendicularly for 90ft., keeping a remarkably uniform width of 2½ft. It has been worked for over 200ft. and may extend further in a north and south direction. Mr. Beatson got the mine second hand, and could not give accurate details of its former history, but believes that a good deal of gold was taken from the upper part of the reef before it came into his possession. In the commencement, before he had the battery, he used to cart the stone twenty miles for crushing, and still it used to pay; and by this means he was able to buy machinery. With all the expenses of labor, &c., the mine paid moderately well until they got down into stone full of pyrites which their machinery could not treat. They continued the crushing for some time, but the amalgam got carried down into the creek. The tailings gave on assay 1½oz. to the ton, and as these were being put through, the pump got out of order and the work was stopped. The stone latterly has averaged an ounce to the ton. The gold was very good—always up to £3 19s. an ounce.

Mount Shoobridge.—About eight miles west of Beatson's mine there is a series of detached hills, the highest probably not much over 300ft. above the plain, or, say, at most 500ft. above the Howley. These hills are for the most part truncated cones. The summits are covered with a thin capping of ferruginous sandstone, horizontally stratified and between 20ft. and 30ft. thick. The hills themselves beneath the capping are composed of a micaceous slate of beautifully silky lustre, or rather the stone appears as if freshly moistened with dew drops. This slate is full of joints, and the stratification difficult to make out. The hills are all connected together by very low ridges with quartz reefs on the crests and sides. On one of the outcrops of quartz, about four miles south of Mount Shoobridge, there is a most singular show of large crystals of mica, black on the edges, but of pale yellow color where not weathered. Some of the plates are more than two inches across, and give a dazzling effect when the sun is shining on the stone. There is very little felspar, no iron, but much white quartz, amid which there is a fine show of black tin ore. There are several parallel lodes of this nature, two or three of which have been uncovered to the extent of removing about a ton of the ore. This reef was discovered by a miner of the name of Snadden, but it is now owned as a mineral selection by Messrs. Nash & Co.

A number of other claims have been taken out on this country which certainly shows very rich tin indications. Here and there are marks left by prospectors, such as costeeing trenches, small pits, a little raised stone on the outcrops of quartz lodes. Thus, on a claim of V. G. Solomon's, there is a small lode exposed which shows a little tin, but the work has not been carried more than two feet in depth. But the most remarkable "blow," as the miners term it, is on Cruickshank and Barrett's claim on a southerly extension of the same range, but probably a line of lodes much more westerly than those previously described. This is a quartz outcrop on a ridge not more than a few feet above the plain. It stands out almost like a wall and is perfectly dazzling from the large plates of mica with which it is covered. The stone which is exposed is thickly marbled with veins of black tin ore. A little work has been done here in uncovering the reef. As far as this has gone there is a very fine show of tin. One block, which lies in the trench, is a beautifully rich specimen, containing about a quarter of a ton of ore. It is worthy of being exhibited in any colonial museum. Altogether, the place is a curiously beautiful mineralogical display. There are large quartz

quartz crystals in the stone, and the bunches of mica, which edgeways look like large black crystals, and on the planes of cleavage like plates of silver. Then the slates at each side are composed of coarse glittering black mica scales all combining to make a surprising display of light color and variety of forms of crystals. This remarkable tin mine was discovered by a miner named G. Barrett, who took it up in partnership with another miner. This was about four years ago. From that time little or nothing has been done.

It is difficult to get people to believe in the stories about Northern Territory mines, still more difficult to get capitalists to join in working them. Generally there has been a tendency to exaggerate the first discoveries, and the reaction has turned capital away. "It can hardly be supposed that the Mount Shooobridge district will have its treasures of mineral wealth long unworked. Then much more than merely appears on the surface will show that this is a metalliferous country of no ordinary character.

Bridge Creek.—This is an alluvial diggings on some open flats between low ranges of quartz and diorite dykes, about a mile or so south-west and south of Bridge creek (a tributary of the Howley). The whole formation partakes of the usual character which all the alluvial quartz diggings in the Northern Territory manifest with two peculiarities. One is, that the quartzite in the alluvial is often like flint, white on the outside with a black core in which there were faint traces of stratification. The second is, that in the alluvial there are small boulders of whinstone or the hornblende porphyry, which occurs as a dyke in so many portions of the mineral country to the southward. There are also stones of magnesia, carbonate, and many pebbles with stains of blue and green carbonates of copper. No doubt there is a copper lode at no great distance. One small quartz leader is worked, and in this the stone is crushed by hand. The alluvial extends all along the creek. The gold is so fine and sealy that it floats away in the panning. Only about twenty white miners are now working (July, 1886), though the gold is by no means worked out, and the alluvial might be called rich, but provisions, &c., are too dear in the Northern Territory to enable a miner to pay his way. There are many Chinese miners, and there will soon be none others. Bridge creek diggings is one of the many instances hereabouts of low ranges producing rich alluvial. Probably there is no country in Australia where, as a rule, the gold veins are in ridges so little elevated above the plains.

Fountain Head.—This is a very remarkable mining district or area, about six miles north of the Port Darwin camp goldfields. What is remarkable about it is that it is situate in a wide plain, and there is no creek or watercourse of any kind, but just a small stony hill of gentle acclivity rising to about 60ft. above the plain. All around this hill for half a mile or so, and on its slopes to the summit, the ground has been turned over and over, giving rise to a series of gravel mounds. The gravel is small and angular. Not the slightest trace of water-wearing can be seen. The fragments are slate like the Union and Sandhurst, mixed with much blue quartz. With the exception of the reef the hill is entirely composed of these fragments, apparently derived from the reef on the summit. There was a large amount of gold found in the alluvial, all worked by Chinese, of whom there were as many as three hundred on the ground at one time. The quartz reef on the summit runs N.N.W. and S.S.E. It is about 12ft. wide and was worked for gold. Some tons of stone were crushed, but it did not produce more than one ounce to the ton, so the lode was abandoned. Yet it is a most remarkable reef, probably containing much valuable mineral. Samples have been carefully selected with a view to further analysis. There are two points of especial interest in connection with this hill. One is that it is not an outcrop of slate, but is nearly entirely composed of detritus from the reef. Secondly, this rich alluvial diggings on an open plain gives rise to the expectation that many more of these open valley plains will prove to be auriferous. There are plenty of such where quartz reefs are known to exist, though they do not crop out, and from all a rich alluvial may be expected. To the south of the lode distant three quarters of a mile there were some leaders or narrow quartz veins found. These were worked by Chinese, who carried the stone to Yam creek to the battery, distant six miles. It turned out well, but not good enough to pay the enormous expenses of carting, crushing, &c.

The Fountain Head diggings are still worked by a few Chinese who seem to make wages by turning over the old gravel. In the rainy season there are always plenty of the same miners, for in the dry months there is no surface water, but this would be easily overcome, for at a depth of 20ft. there is abundance. The appearance of this field from the top of the hill is very peculiar with its miles of gravel heaps on a wide, stony plain. It may yet be an important mining centre. At the Wulwonga diggings, a short distance north-east of Fountain Head, there are some flat leaders, yielding in a trial crushing about an ounce of gold to the ton. North of Glencoe station, about six miles, there are some likely-looking patches of country; it is close to the granite junction.

Extended Union.—These gold mines lie about three miles S.E. of Springhill. Between them there is a dyke of porphyry of the same character as that already described. It is very hard, and stands up in conspicuous flag stones like tombstones, with the edges set in a N. and S. direction. The range on which the mines lie is rugged and broken—that is to say, it is broken into low conical hills about 300ft. above the plain, and connected with each other by low saddles. The lower ground is one mass of the usual turned-up slates, whose jagged leaves bristle out of the ground like the "quills upon the fretful porcupine." In the midst of this sort of country are the mines.

First of all, there is a good deal of turned-up ground in the gullies hereabouts, and the nature of the country shows that the whole of it might, nay, perhaps will, be in a similar condition, for the gold is not half prospected, and it is impossible for such masses of quartz rock not to have had shoots of gold which have weathered into the plains below. There are shoots of gold in the hills, too, as yet untouched. It is mere chance-work finding them. A prospector sees a quartz reef and gives it here and there a few blows with his pick or hammer. From this he pounds a few specimens in a mortar. If no gold is found, henceforth the reef has a bad name as hungry quartz, or it may be, as at Pine creek, a good show is found, and though there are many barren ones prospecting and working goes on. At the Extended Union a great mass of stone has been taken out, and the cap of the lode looks like an empty quarry. It was formerly a tangled mass of leaders, going in every direction. These were very rich, giving as much as 80oz. of gold to the ton. By and bye the reef was found; of poorer stone, but still good; very good in any country but this. It was worked—bungled and mismanaged—in a way that need not be chronicled here. The first owners sold out, and their successors put down a shaft farther out to catch the lode. This was sunk until the money was exhausted, but the reef was not reached. Then the mine was let on tribute to Chinamen, who are working it now. They have sunk a new shaft nearer to the first, but have not caught the lode at 100ft. The property is a good one, and, with good management, will yield large returns.

South of this mine is the Isabel, worked formerly by Messrs. McIntyre and Dalmer. It is a fine reef of stone, nowhere less than 6ft. wide, and in some places much more. The owners got from 209 tons of quartz 268oz.

of gold; but when they got down 25ft. the water was too much for their resources, and from that day to this they could not raise money to proceed farther. The same owners have another claim, called Pender's Hill, which adjoins the Isabel. In this the shaft was sunk 70ft. and 124 tons of stone got, which yielded 169oz. of gold. This is not working now; as usual, no capital to proceed further.

The Union.—These mines may be said to be amongst the greatest and richest deposits of gold in the Northern Territory. From the prospectors' claim on each side there are twelve claims, north and south, or, in all, twenty-four claims, extending for nearly three miles. The whole of this line of country may be said to include good reefs of payable stone—payable, that is, in other colonies. Besides these reefs, there are those which lie nearly parallel on the east side, perhaps joining it at No. 5 South Union. In the commencement the eaps of these reefs gave wonderful results from the early crushings, as usual in such cases. For these the reports of Chief Warden Nash may be consulted, but 60, 70, and 80ozs. to the ton have been recorded. It may be safely said that though this field is lying idle, or nearly idle, and the claims have been deserted and abandoned one by one, in no case has it been for want of good auriferous stone. The gold is there and it can be confidently asserted that the resources of the mines have been comparatively untouched; but they present a sad prospect now with all their treasures almost abandoned.

When the Europeans began to give up working their claims a good many were let on tribute to the Chinese. The average of the crushings was nearly 1oz. to the ton: some of the stone was very good indeed, such as No. 1 South Union, 15 tons stone, 81ozs. gold; 22 tons 144ozs.; 9 tons 20ozs.; No. 10, South Union, 32 tons 150ozs.; and so forth. But the stone should have yielded double the above amounts, and for this reason the only battery on the field was almost useless and wasted half the gold. Before this was understood the Chinese went to work merrily, and for some time the stone was raised faster than the battery could crush it, but the results discouraged them. The wretched battery could not properly crush the stone, or could not deal with it. Thus, between waiting and disappointments, the margin of profit from the gold dwindled away, and one after another the tributors gave up.

It is worthy of remark in connection with these mines that the stone and the country, and indeed their whole character, is exactly like Sandhurst, in Victoria. The gold, however, on the Union reef is not so good as on the rest of the Territory. Not so the Lady Alice; there the gold is very pure; yet the latter reef inclines in a southerly direction towards the Union, and ultimately joins it. The Union mines may be truly called the Sandhurst of the Northern Territory, and probably will be found little if at all inferior to Sandhurst as a mining district.

Pine Creek.—This is another large mineral district, about ten miles south of the Union, and the terminus of the railway. Like the latter, as like all the mines in this country, it is a series of quartz reefs in slates having almost a meridional direction; but the ranges here are not truly meridional. They run almost north-west and south-east. The quartz lodes are the same. Amidst the quartz lodes there is a variety and extent of minerals which has few parallels in other countries—gold, silver, lead, tin, and copper; the latter in a good lode four miles further south. Once this district attracted much attention, and a comparatively large population—large that is for the Territory, and very large to what it is now, for there are only four claims working, those of Messrs Mullen and O'Donohoe, both are giving excellent stone. Mullen got 360ozs. of gold from 30 tons of stone. This will give an idea of what the country is. Since the Eleanor has been worked by Mr. Jansen, about five years, he has got about 9,000ozs. of gold from it. He has a battery supplied with water from a dam, and even as late as the end of August he had still water to keep the mill going for eight hours daily.

It would take one a considerable time to specify the numbers of reefs which crop out on every side in this extraordinary mineral country. Here is an example. Close by Mr. Jansen's house on the flat below the range there is a silver reef just showing above the level. A small pit about 3ft. deep has been dug on the top of this. The assay of the ore showed silver, but no more has been done. But the whole of this country gives more favorable indications of mineral wealth, and one cannot speak too highly of it. It is useless saying more as to what the mines are to what they might be, or what the field might be if there were capital to work it. Some day surely these deposits of gold, silver, copper, &c., must yield up their treasures. It should be added that stream tin has been found at no great distance from Pine creek, and there are other indications of tin veins. If they have not been found it may be confidently asserted that they will be in the course of time. A careful survey of the field would reveal literally hundreds of mineral veins which are hidden now. There has been a good deal of alluvial working, but there is a large area of surface untouched.

The slates about Pine creek have been formerly a kind of carbonaceous shale. In many places partings can be obtained as thin as paper, and on both sides are covered thickly with indistinct carbonaceous markings. They are undoubtedly plant remains, but in the specimens exposed not distinct enough for identification. This discovery in such old rocks is very interesting, and may lead eventually to some accurate position in the geological scale for the auriferous slates of the Northern Territory.

McMinn's Bluff.—The road from Pine Creek by the side of the telegraph line passes along a valley formed by a flat sandstone tableland on the west side, and a low slate range on the east side. The west side of the valley is granite, and this also forms the base of the hills. The eastern side has a much finer grained granite of quite a different character. This is well seen at the base of a detached series of three hills called McMinn's Bluff. At a place called the Rocky Waterhole, on the east side of the valley, the rocks are close grained and extremely hard. It seemed to me that the felspar is plagioclase. Probably the rock is a dyke or vein, and newer than the granite of the west side, which is the basal granite of the country. This is so coarse-grained as to be more like a granite porphyry than what is usually called granite. The crystals of felspar are sometimes 3in. or 4in. long. They are orthoclase of very pale pink or grey or faint blue. The mica is golden-brown, but in masses looks black. Both these granites decompose into a white powdery soil, which pulverizes into the finest dust. It is important to bear this in mind when we come to look for the origin of the so-called desert sandstone.

The tableland forming the western boundary of the valley is at its southern end, a long narrow range, covered with a stratum of stone which stands out like a rampart some 30ft. or 40ft. thick, and giving a castellated appearance to the flat-topped hills. As the range is followed north it is broken into three or four small outliers of white and red color. They look like ramparts and fortresses, and are of very picturesque appearance. They all have a steep incline for about two-thirds of their height, then become rugged for some distance, and then suddenly precipitous for 34ft. to their flat-topped summits. One of these hills is of fiery red on the top, and it is joined by a low saddle to another outlier which is capped with picturesque cliffs

cliffs, which are white. The section of these hills is as follows:—Granite, 90ft. at least; it may be more, but the line of junction is concealed by weathered masses of rock, which have fallen down from the cliffs; then follows 100ft. to 150ft. of coarse red sandstone; then 30ft. to 40ft. of magnesian silicate, making a total at the highest of about 270ft. above the plain. The coarse red sandstone lies in horizontal strata. It consists of large quartz grains embedded in a reddish-brown cement. Its materials have no apparent connection with any rock visible in the valley now. The upper stratum is a compact rock with small vesicles. It is either creamy white, yellow, or mottled, or deep-red brown, with streaks and veins of lighter color. There is a concretionary character about its decomposition, which makes it break up into a number of small red rounded pebbles, like pea-iron ore. But this is not always visible, only where there is not much iron-oxide. In other places it is a pure white, and consists of a magnesian silicate. These cliffs seem to be a decomposed volcanic ash, possibly mainly derived from olivine.

There are three things to be particularly noted here:—(1) The so-called desert sandstone does not form a continuous tableland. (2) It lies in comparatively thin strata of sandstone, and magnesian silicate capping other rocks, usually granite. (3) It does not attain at McMinn's Bluff, a height of 300ft. above the plain.

The Eveleen Silver Mine.—This mine is situated on nearly the south-eastern extremity of the metalliferous ranges, about four miles west of the upper reaches of the River Mary. As already stated, it is situated on a small patch of limestone exactly on the junction of the metalliferous slates with the blue granite of the valley of the Mary. The formation is probably paleozoic in alternate strata of chert and limestone. There are many small outcrops of the usual character of limestone, but the outcrop, called here Pinnacle Hill, is a pile of boulders rising abruptly from the plain and covering several acres of ground. There are many lodes visible in this hill, the main one of many feet in width with wide brilliant shoots of galena. There is also much copper in the stone giving rise to veins and crystals of blue and green of the most lively colors. There are an immense number and variety of minerals in the veins and pockets forming a sight of rare beauty. Some very uncommon minerals are found amongst the stone, which can be easily imagined from the combination of silver, lead, copper, iron, and probably nickel. It is said that the percentage of silver in the lead is very high. It looks well, and it is easy to extract silver even with a blow-pipe. The copper ores are poor and light. The company are going to great expense in machinery, &c., and seem determined to test the property. Its proceedings will be watched with much interest. If billion lead can be produced and exported so as to pay at the present rates of labor and cartage, it will be a great thing for the Territory, and any failure would do much injury to many mines. We must hope for the best, and hope also that prudent and economical management which the mine will require may contribute to this. At any rate the property is a very good one as far as it has been explored.

Many other discoveries of argentiferous galena are reported, as I have stated in dealing with the subject of silver lead. About two and a half miles south of the Spring Hill mine, where an auriferous quartz reef is worked by a miner named Robertson, a lode of silver lead has been found close to the Elizabeth creek. The ore is reported to have yielded a very high assay. The whole country thereabouts is rich in minerals, and the prospector evidently thinks so too, for he has taken out nearly a square mile of it.

Household's Rush.—This is an alluvial and reef gold field, about four miles south of the Eveleen, and extending it is stated for about seven miles. The sinking is very shallow in a soft ferruginous slate, with no drift or wash properly speaking. There is a lode worked by some Chinese in a band of decomposed limonite or ironstone. It must be very rich, for gold was visible in all the matrix, which is a very red gravel. The great difficulty on this field is the want of water. It can only be worked for about six months in the year, yet to me it seemed as good a field as any I have seen in the Territory. There must be other reefs—many others I should say—of the same ironstone cement which only require careful searching for, as the country is full of the same material. As usual only Chinese are working now on these mines.

PROSPECTING EXPLORATION.

On the 20th August I started from Burrundie accompanied by Mr. Surveyor Hingston, two men, and ten horses, to explore and prospect the country between Mount Wells and the Katherine river, by way of the Eveleen mine. Our course at first was due north to Mount Douglas, a very conspicuous hill visible from Mount Wells, said to be granite; beyond this I could get no information. Mount Douglas has been prospected by few miners, but no one could I meet with who had proceeded further. We reached the mountain in question in two days. The intervening country consists of low slate ridges, with sharp and bristling outcrops of slate, quartz lodes and phoscolite dykes. It is entirely an auriferous country, any portion of which may contain alluvial or good reefs. The country is well watered but rough to travel from the stony nature of the soil, and the many tributaries of the McKinlay along which our course lay. Mount Douglas consists of a coarse, slightly reddish quartzite, enclosing many rounded water-worn white quartz pebbles with faint blackish lines of specular iron. The pebbles are generally sparingly scattered through the stone, but there are sometimes thick strata of conglomerate with fragments of slate and numerous veins of segregation (quartz) of small size. The formation is in fact what I have described as fluvatile sandstone. It dips away from the river at an angle of 30° or more. The base and sides of the mountain are covered with enormous masses of boulders which have broken away from the summit. It is cross-bedded and evidently a derivative formation from the wearing down of auriferous rocks. We ascended to the summit easily; the highest portion is only 550ft. above the plain, though most of it is much less. It is about two and a half miles long and a quarter of a mile wide. On its northern base the River McKinlay flows, and on the opposite side of the valley arises a low river range doubtless of the same fluvatile conglomerate formation. The base of the formation may be auriferous, but in the sandstone no mineral exists.

We continued to pursue a generally south-east course from Mount Douglas, which is connected with moderately high and steep but very stony ranges of slate, felsite, and hornstone, broken by weathering and the original jointing of the rocks into a kind of metalling of 2in. gauge. There is no surface soil, but the ground is deeply covered with these stones, like a shingle beach. We continued through these ranges for several hours. They are separated by open valleys and mud flats, with dry creeks and poor timber, and occasional outcrops of mineral veins of quartz, with, I believe, silver lead; there were also porphyry dykes. A gully to the east brought us into granite country, and so on to the plains of the Mary river. Another day's travelling to the south-east brought us into the ranges again, which here stretch out far into the eastern plains; the ridges became very high and almost impassable. The stone is slate, but differing from the auriferous slate. We passed the capping of four or five mineral lodes. The whole country about is of a promising character for minerals, mostly, I should say, for silver lead, though perhaps for gold also.

When

When we had prospected for some time and found the ranges becoming much too high for the horses, we descended from them into the eastern plains, and camped at Francis creek, near some fine reaches of water, where we got colors of gold. Here again were the cappings of mineral lodes. From this point to the Eveleen mine our course was more easterly, leading us into the granite plain. The granite is blue, close-grained, and forming hills and heaps of boulders 100ft. or so in height. To the westward the slate ranges continue, with promising indications. Through this part of them the track to the Eveleen mine has been made, so that the neighboring country will soon be well known.

The Eveleen mine I have referred to in another place, as well as the curious limestone country. At the Eveleen we were joined by Mr. Nash, the chief warden. From the mine we went to Householdt's rush, about four miles south. This also I have described, and I need only add now that this country is all of an exceedingly promising kind, and will yet, I am convinced, be found yielding much valuable mineral. It is very little known. From Householdt's rush we went eastward to the Mary, and on the second day's journey along its banks came upon the camp of two prospectors, Messrs. Roberts and Hann. Here we remained a couple of days resting the horses and examining the country in advance.

In our course to the Mary we had passed over auriferous slates with porphyry dykes, differing from anything observed in the northern portions of the range; the small veins of ironstone and quartz cropping out here and there are all of most promising character. In passing along the valleys of the Mary, as we travelled south, we soon found ourselves hemmed in between the ranges and the river valley, which is too boggy for horses to cross without a long delay. The range was granite at the edges and slate further to the westward. All the ranges are very steep, but scarcely 300ft. above the plain. Many outcrops of quartz and other mineral lodes were seen, notably a copper lode, and probably one of silver lead. This end of the ranges is full of excellent indications. From what has been observed by myself hereabouts, I think that the southern end of the ranges will prove to be richest in minerals at the junction with the granite. There are several hundred square miles between the head of the Mary and Pine creek, most of which is not prospected, and all of which may reasonably be supposed to contain metals, and especially gold and silver-lead ore.

We reached one of the heads of the Mary in three days, travelling from the Eveleen mine. The last half day's journey was through high narrow gorges, formed by cliffs of white magnesite and sandstone, which looked like chalk; some, however, were not white. At a fortress-like outlier, opposite our camp, the following was the section:—the base was white with large stains of red and yellow, and brown; then there was a talus slope 120ft. high, consisting of ferruginous sandstone in blocks, scattered amid trees and grass; then there was about 40ft. of cliffs at the top, the lower half white and the upper 20ft. yellow and red. Of the floor of the valley we could see nothing, as it was so thickly grassed or covered with immense fragments of magnesian sandstone, fallen down from above. Our camp at the head of the Mary was Douglas springs, a beautiful shady valley with abundance of tall cabbage palms (*Ptychosperma*). We found a passage to the top of the cliffs without difficulty, up a gorge 180ft. above the valley. There was a gap in the perpendicular cliffs which, with a little cutting, and the removal of stones, became perfectly accessible. Inside this was another rampart, some 20ft. high, so that in all the height was 200ft. above the valley. The summit was apparently a perfectly level plain of poor open forest; but it rose in imperceptible incline, for about six miles, about 30ft. a mile, then it descended by an inclined plane for about five miles, until we came to springs and a creek 100ft. above the Mary river. Here auriferous slate re-appeared, and then a red porphyry rock, which is no doubt Leichhardt's pegmatite. The name pegmatite was a term much in use formerly, and applied to a kind of granite without mica, or mica in minute quantities. Base of quartz, with the felspar crystals lying separate in the quartz. The term is now disused. Until the rock has been carefully examined it will be referred to here as red porphyry.

The creek we came upon was Kekwick's fine springs, where Stuart camped twenty-five years ago. We looked for his camp, but could not find it, though ancient tomahawk marks were visible on some of the trees. From this point the country was all red porphyry or pegmatite, for some days, mingled with a little fluvial sandstone at Kekwick's springs, and occasionally dykes of blue basalt or phonolite. We reached the Katherine river in two days. It is here a very fine river, with a deep wide valley, long reaches of water several miles in extent, and flood-marks on the trees 10ft. and more above the highest banks of the stream. The river valley is at first through porphyry ranges, but it gradually narrowed into gorges of fluvial sandstone, quite impassable even on foot. The river also was confined between precipices of the same stone, some 50ft. in height. We lost three days in trying to find a passage through these fluvial conglomerates, which hem the river between cliffs, forming gorges of varying width extending to over two miles. Ultimately we struck eastward again, crossing the tablelands, and we found beautiful springs and valleys at the base, with good grass. The ranges are about 300ft. above the plain, thickly timbered, with grassy valleys and large springs of water on the very summit. We found the first cliffs a mere ridge, very rough and stony, and rising to 400ft. above the plain. A series of ridges continued, and then a level inclined plain of three miles or so. By this we descended 150ft., and then came to the head of a rocky gorge, which proved to be the head of Maude creek. This we descended until we reached almost the level of the Katherine river, and found auriferous slates cropping out. I do not think the country very promising, but still it is a mineral formation which wants prospecting. I saw no traces of mineral lodes.

From Maude creek we came in a few miles to Galloway's cattle station, which is fourteen miles from the telegraph station on the Katherine river. Here porphyry reappears, and low ranges of fluvial sandstone, forming rough stony country. At the telegraph station is the limestone already described, which continues for ten miles north. Then succeeds the volcanic area nearly as far as the Phillips, at which is a promising auriferous country full of quartz reefs. This continues to the Fergusson by Mount Todd and the Driffield river. It seems more an auriferous country than likely to produce minerals such as we find on the eastern side of the ranges near the head of the Mary. From the Fergusson the granite crops out to within three miles of Jansen's mine, at Pine creek. Thus the whole metalliferous country between Pine creek, or the end of the auriferous ranges and the Katherine river is about fifteen miles from north to south. I had not time to ascertain its width. I heard that some eight years ago two men got 280zs. of gold by breaking it out of a reef at the head of the Driffield. Some prospecting parties were there at the time, but nothing very rich was found, and other places had greater attractions for the miner. It is said that to the westward of the auriferous ranges, say at Pine creek, granite succeeds, then narrow belts of magnesite tableland, and then granite again, until the ranges at the sources of the Fitzmaurice are reached. This I have not seen, but, if true, it will guide prospectors to point out to them that the locality best worth inspection, and which will most likely lead to discoveries on the slate country, is the junction between them and the granite.

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The Victoria River.—Before undertaking the prospecting tour for the Government, I was, through the kindness of Mr. Stevens, of Palmerston and Glenelg, enabled to visit the Victoria river. Though not connected with my tour in the Northern Territory, I may here state the general results—For sixty miles above the mouth I found the river bordered with fluvial sandstones and conglomerates exactly like those here described. At first these rocks formed a wide valley, and then narrowed into precipitous and very narrow rocky gorges. The stone is red and mottled, and dips away from the river at a high angle. There were also high outliers of broken tableland visible inland. Higher up, the river runs through good volcanic country. I do not think that the fluvial quartz conglomerates extend to any great width on either side of the valley, and the nature of the country beyond is not accurately known.

CONCLUSION.

I have one or two final remarks to make, and not exactly within a geologist's province, but still whereon my opinion may be of some weight. The Northern Territory is just passing through a period of extraordinary depression which, in spite of its mineral riches, has nearly destroyed the mining industry. One cause has been frequently referred to, that is, the high rate of labor. It is hoped that the railway will remedy this, and I need not say anything more about it where I have no advice to offer. Another cause of the depression is the way in which the mineral lands are locked up. The great mass of the mineral lands are held by persons who do not work them, and who cannot work them. As soon as a mineral discovery is made the Land Office in Adelaide is besieged by speculators, taking out thousands of acres all around, who mean to hold over until the discoveries are tested. This ruins the country, for it prevents the development of mineral riches. While the prospectors should be liberally dealt with the mere speculator should be excluded. No one should hold mining land beyond a reasonable time without working it. Legislation should deal with this.

One more remark will conclude what I have to say. I think that the Chinese should be entirely excluded from the goldfields except as hired servants. At present the whole gold mining industry of the Northern Territory is bound hand and foot, and handed over to the Chinaman. I have seen something of China, and much of the Chinese, and I say we will one day regret any supremacy we give them. On the labor question I offer no opinion, but I have very strong opinions about giving up our mines to this people. If the Northern Territory belonged to any other European nation its mineral resources would have been made a source of splendid national riches and prosperity, while we simply stand by and let them flow into the coffers of the Chinese Empire. If we cannot make use of them now it will not be always so, but what folly it is to let this alien people quietly carry them away. Future generations will be amazed at our imbecility in this matter, and future colonists will loudly blame the culpable ignorance which despoiled the country of its best though happily not its only inheritance. If the Chinese want to work for us it may or may not be wise to employ them. On that matter I do not pretend to decide; but they should not become proprietors of our treasures, for which the majority do not condescend to pay even a miner's right. Thus we shall keep our own, and if this procedure does not remedy existing depression when better times do come we shall not find our inheritance gone. This is a matter which should be dealt with at once, for it admits of no delay. I cannot conclude this report without expressing my grateful obligations to the Government Resident and to every colonist of the Northern Territory for the kindness and hospitality with which I have been received, and for the untiring zeal with which my inquiries were assisted in every possible way.

I have, &c.,

J. E. TENISON WOODS.

To the Hon. John A. Cockburn, Minister of Education, Adelaide.

To accompany the Rev.^d J.E.Tenison-Woods' report on the geology of the

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