David Scott Mitchell.

1885.

WESTERN AUSTRALIA.

REPORT

ON THE

GEOLOGY

OF THE

KIMBERLEY DISTRICT,

WESTERN AUSTRALIA,

BY

EDWARD T. HARDMAN,

F.R.G.S.I., ASSOC. ROY. COLL. SCIENCE, DUBLIN, ETC.,

OF H.M. GEOLOGICAL SURVEY OF IRELAND.

Presented to the Legislative Council by His Excellency's Command.

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Report on the Geology of the Kimberley District, Western Australia, by Edward T. Hardman, F.R.G.S.I., Assoc. Roy. Coll. Science, Dublin, &c., of H.M. Geological Survey of Ireland.

SIR, Perth, 1st August, 1885.

I have the honor to transmit herewith, for the information of His Excellency the Governor, my Report on that part of Kimberley examined during the Survey of last year (1884). I have already had the honor to submit to you a map, sections, and drawings to illustrate the Report.

I have, &c.,
EDWARD T. HARDMAN, F.R.G.S.I., &c.,
Government Geologist.

To the Hon. John Forrest, C.M.G., &c.,
Surveyor General and Commissioner of Crown Lands,
Western Australia.

REPORT.

I.—GENERAL DESCRIPTION.

1. The district examined during the year 1884 lies between latitudes 16° 40′ and 19° S., and between 126° 30′ and 129° 30′ E. longitude. It includes the portion of country extending in a North-easterly direction from the southern extremity of the Leopold Ranges, up the course of the Margaret River and its tributaries; across a portion of the main watershed of Kimberley, and the Ord River and its tributaries, to within 245 miles (as far as has been ascertained) of where that river falls into the sea at Cambridge Gulf. The furthest point eastward examined is Mt. Panton, which lies 14 miles East of the boundary of South Australia, and the area mapped is about 10,000 square miles.

2. Thus, during the two years 1883–4, a complete Geological section has been obtained from Roebuck Bay across the Colony to the Northern Territory.

3. I may add, that I have taken advantage of the opportunity afforded, in travelling a second time up the Fitzroy, to examine localities I had not time or facilities for examining during my former trip. But I have been able to verify my conviction, as stated in last year's report, as to the immense spread of the carboniferous rocks in the Kimberley District, inasmuch as I have obtained, along the Fitzroy River, numbers of fossils characteristic of that formation.

PHYSICAL GEOGRAPHY.

4. *Form of the Ground.*—This differs materially from that observed in 1883, and reported on last year; the country traversed at that time consisting of low very slightly rising ground, occasionally diversified by low rocky hills and some few isolated ranges. But on reaching the southern corner of the Leopold Ranges, we passed from wide and well-grassed alluvium flats into very rough rocky and hilly country, for the most part covered with *spinifex*. On the North, the view was bounded by the Mueller Ranges (a part of the King Leopold Ranges), which stretch away for many miles to the North-east; while to the southward and South-west are frequent alternations of undulating ground, from which rise numerous low hills, usually of a rounded or conical shape. These are chiefly composed of the granites and metamorphic rocks. Still further South may be seen rugged hills, composed of rough limestone, succeeded by sandstone showing in flat-topped hills, apparently the continuation of the limestones of Rough Range, partially described last year, and therefore of carboniferous age. [See Report, 1884.] This portion of the carboniferous range seems to rise to a considerable height, and is a very prominent object in the landscape. I have named these hills Haughton Range.* A curious feature in this part of the district is a great accumulation of gravel and boulders, forming rounded hills extending several miles to S.E., and some hundreds of feet in height. They lie 8 or 10 miles S.W. of the Mueller Ranges.

5. I may here mention that the Mueller Ranges, forming the S.E. edge of the Leopold Range Plateau, are composed of similar rocks, namely, quartzite and altered grits, probably of Lower Silurian age. They attain an altitude of from 1,000 to perhaps 2,500 feet (Mt. Malcolm), and present the appearance of high scarped cliffs, over-topping a steeply sloping *talus* resulting from the accumulating *debris*; and although the general configuration of these mountains is that of a more or less flat-topped plateau, occasionally high conical peaks are seen rising above the usual level. Of these, the most remarkable are Mt. Huxley† Mt. Ball,‡ and Mt. Malcolm.§ (*See* Plates 3, 11).

6. The country rises very rapidly after leaving the plains of the Margaret, which were estimated, in 1883, to lie about 300 feet above the sea level, but which from barometric readings on the last trip, 1884,

* After Revd. Samuel Haughton, F.T.C.D., D.C.L., F.R.S., &c.; well known as an accomplished geologist and scientist.
† Called after Professor Huxley, P.R.S.; mistaken for and referred to last year as Mt. Krauss.
‡ Called after Professor R. S. Ball, Astronomer Royal of Ireland.
§ Called after the Honorable Malcolm Fraser, C.M.G., Colonial Secretary.

appear to be 145 feet higher (that is, 445 feet). Within 18 miles, the ground has risen 300 feet, as shown by several observations; but travelling as we did over very rough undulating ground, it was very difficult to observe at the moment that we were really going up or down hill. The inter-position of occasional wide flats would also tend to give the idea of passing over a country of much the same general height. Yet, after a journey of some 100 miles, the steady fall of the barometer could not escape notice. I shall give further on a list of heights as thus observed, and calculated from daily readings at Derby. It must be noticed, however, that owing to the circumstances under which the party travelled, the observations could not always be simultaneous, and therefore the levels can only be regarded as approximating to the truth. Suffice it to say that they show roughly that the main valleys along which we traversed rise gradually to a height exceeding 1,200 to 1,300 feet; and crossing a portion of the watershed at 1,400 feet, some 250 miles from the Western coast, the levels diminish to 362 feet on the River Ord about 130 miles *in a direct line* from Cambridge Gulf.

7. Our course lay generally in a North-easterly direction, roughly speaking, although it was necessary to make many divergences. It will be observed, on looking at the accompanying map, that there is a large portion of it colored to represent the metamorphic rocks, together with granites, &c. This band of country occupying itself a considerable area, and although in places often more than 1,000 feet above the sea with occasionally very high peaks, may be regarded as a vale enclosed to the N.W. and S.E. by two important ranges of hills. One of these is the Mueller Range, the other is a high sandstone range, which, rising with a very abrupt precipitous face from the metamorphic rocks, can be seen trending North-westerly for many miles. From many points of observation, we have been enabled to trace its course as drawn on the Map, showing its extension for more than 120 miles; but it probably continues much further both North and South. It is distinctly visible from the hill tops for 40 miles, its stratified escarpment showing at that distance like a wall of masonry against the sky. A sketch of this range is shown in Plate 9, taken from a hill about 20 miles to the West.

8. The rocks of which this range is composed are probably of Devonian age. Its height above sea level varies from 1,170 to 1,650 feet. It is one of the most interesting and important ranges in the district; and I have humbly ventured to dedicate it to H.R.H. The Prince of Wales, under the title of the Albert-Edward Range.

9. The sections accompanying this Report will explain graphically the general features of this country.

10. Another very important range is formed by a series of high flat-topped hills, which are first visible from the southern points of the Leopold (or Mueller) ranges, and lie to the S.E. of these, some 10 miles or so. These mountains are composed of Devonian grits and sandstones, and are noticeable for their generally almost horizontal outline and bold escarpments towards the Margaret River, which flows within a few miles of, and sometimes close by them. This range I named Lubbock Range.

11. At the extreme southern extremity of this range the Margaret passes between it and an outlying series of low hills extending about two miles to the south-east. These hills are almost entirely composed of flint, chert, calcedony, agate, &c.; and on them are quantities of chips, and half-finished, or spoilt, spear-heads, the work of the aborigines; almost similar in type and appearance to those fragments with which all archæologists are familiar, as occurring in the European drifts, gravels, and caves. It appeared to me, therefore, that it would be most fitting to name these ranges after Sir John Lubbock, Bart., F.R.S., the author of "Prehistoric Man."

12. The mean height of these hills above the valleys or river plains is about 400 to 700 feet. Above sea level the highest points at which observations were made were found to be 1,027 feet and 1,468 respectively. Their plan-line is that of a semicircle extending for some 30 miles, and the extent of the more prominent hilly district would be about 15 miles E. & W., and 12 N. & S.

13. Looking to the S.W. from the principal point of this range (J 19), and across the well-wooded valley of the Margaret River, another range of Devonian formation is seen. This range stretches to the southward, and exhibits a gentle rounded outline of gradually rising hills, culminating in a high peak, called by Mr. Johnston Mt. Bertram. It is 1,238 feet above sea level, and between 500 and 600 feet above the river valley. The range extends for about 10 miles, and on close examination is found to be formed of a series of alternating hills and valleys, showing a very regular trend along the lines of strike of the rocks, which are here much contorted into deep synclinals and anticlinals. It is a somewhat unusual circumstance that in this instance the valleys invariably occur in the synclinals, which, however, may be easily accounted for: these synclinals being formed of soft friable shales easily disintegrated; whilst the anticlinals, and, consequently the hills, are formed of extremely hard partially metamorphosed grits and sandstones.

14. To the south-east of this range the contour of the ground is level for some miles, and then it rises gradually into a hilly country of a generally rounded character. The summit of these hills forms a well pronounced peak, and is visible for a considerable distance, about 40 miles. Its height is 1,313 feet, and probably, as estimated, 600 feet above the alluvial flats of the Margaret River. It has not been named, but is marked on the map as J 18.

15. From this hill could be observed to the southwards high flat-topped sandstone ranges, some four or five miles distant; doubtless the continuation of those I have called the Haughton Ranges. They trend nearly east and west, and are evidently composed of sandstones and grits; and in places out-crops of white agates and flints are visible. To the eastward the country is rough and uneven, but low-lying; showing frequent out-crops of tertiary ironstone conglomerates, which usually assume the shape of low flat-topped hills. Further east (approximately ten miles) were seen low rugged hillocks, subsequently ascertained to be granitic: a formation which, in its many varieties (as will be designated further on), has been traced for very many miles in a north-easterly direction. (*See* Map.)

16. To the west the country is of a low undulating character, low flat hills of probably tertiary ironstone showing above the surface at intervals.

17. We obtained from this hill a good view of a remarkable peak previously observed from the Margaret River. This forms a portion of an elevated rocky tract of country chiefly consisting of slates, grits, and sandstones, of the metamorphic formation, which extend, as already stated, in a north-easterly direction in a series of rounded and peaked hills; some of them rise to a considerable altitude, and of these the chief are Mt. Dockrell,* 1,469, and J 22, 1,844 feet. This series of hills, which extend somewhat more than 50 miles altogether, I have called the McClintock Ranges.†

18. Westward of these, about 25 miles, are some remarkable looking flat-topped hills rising to a height of 1,463 feet above the sea, and extending in a zigzag north-easterly direction for 10 or 12 miles. Although apparently flat-topped as seen from the south-east, on closer acquaintance they are found to slope very rapidly to the north-west, the slope being almost coincident with the dip of the rocks, which are of Devonian formation. These hills have been called Ramsay Range.‡

19. The next hill worthy of notice is Mount Barrett, a high peaked quartzite hill, which is noticeable for over 40 miles from elevated ground. Its height as ascertained from barometric readings is 2,216 feet above sea level. It is therefore the highest mountain in the Kimberley District, as at present known. At the same time, I think Mt. Malcolm (already referred to, *see* page 3) must be considerably higher, and I estimate it to be at least 2,500 feet above sea level. It lies about 40 miles nearly due West of Mt. Barrett, and is a very prominent object in the landscape from many points of view. *See* Plate 11.

20. Mt. Barrett throws off several spurs, the most important one of which extends in a general South-westerly direction forming a series of rough quartzite hills, the highest point of which rises to about 1,525 feet above sea level. A view of Mt. Barrett taken from this hill is shown in Plate 9.

21. Eastwards of Mt. Barrett, 10 to 15 miles, are high ranges of quartzites and grits, intermingled with micaceous and hornblendic schists, &c. They have a general North-east trend, and form here the principal boundary of the metamorphic rocks. In places they rise to considerable altitudes, as at J 25, § a trigonometrical station, which is 1,555 feet above the sea level; and the alternation of hard grits and conglomerates with softer schists and slates has given rise to many peculiar and rugged features in the character of the country. *See* Plate 8.

22. To the northwards of the last point, the country is composed of schists, slates, and grits, presenting, generally, apparently a succession of smoothly rounded hills, well covered with grass. On closer investigation, however, they are discovered to be of the very roughest description, consisting of rough schists and grits, whose only vegetation is spinifex. In the distance is seen a very high peaked hill, which has been named Mt. Coghlan, || and which has been ascertained to be 2,062 feet above the sea.

23. Following a deep and rugged river valley—that of the Elvire river—we come to a bold face of rock, a part of the Albert-Edward Range, through which the river has cut a deep gorge, the sides of which rise from 360 to 500 feet above the river bed; the observed height of the ridge above sea level at "the Crater" being 1,170 feet. This "Crater," so called from its very extraordinary appearance,—which would almost suggest a volcanic origin, but which is really due to the ordinary effects of denudation—is in the form of a vast semicircle, about half-a-mile to a mile in diameter, formed of hard indurated Devonian grits. This rises like a wall from the summit of a steep *talus*, which encloses a deep valley. Towards the centre of this valley, which is about 250 or 300 feet below the wall of the Crater, rise massively rounded hills, composed of limestone. These hills, which are of a lower level than the enclosing wall, are, while generally of a rounded shape, cut through in various directions by gullies; and the consequent denudation has disclosed the bedding of the limestone, which dips at a high angle in a very curious series of curved forms. *See* Plate 7.

24. At first sight it might be considered that some tremendous convulsion of nature had once occurred here, breaking up and intermingling the various strata in a state of inextricable confusion; but on close examination it is seen that the stratification is perfectly regular and unbroken. Undoubtedly terrestrial

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* After Lieut. H. Dockrell, R.N., Admiralty Survey.

† After Sir F. Leopold McClintock, L.L.D., F.R.S.; renowned for his Arctic explorations.

‡ After Sir A. C. Ramsay, F.R.S., lately Director General of the Geological Survey of the United Kingdom.

§ I should mention here, to avoid future confusion, and as it will help to simplify description and prevent unnecessary repetition, that many of the hills and camps referred to in this report are only known by the numbered letters, as J 25, J 26, &c., cut on the poles by which they are marked, and which are also printed on the maps.

|| After Staff Commander Coghlan, R.N., Commanding Officer of the Admiralty Survey on the West Australian Station.

forces have been at work here, but the effect has been, besides the uplifting of strata, to bend them, so that the strike forms a nearly semicircular curve. The softer limestones and shales have been subsequently eaten away, leaving the hard ridge of grits prominently conspicuous; while the remaining limestones forming the centre, being unequally denuded at different points of the curve, at one place show an edge of rock, and at another a portion of a face. These limestones form part of a thick band, which can be traced for many miles. It is enclosed on the west side by a similar band of grit to those mentioned above, and which form the outer face of the Albert-Edward Range (*see* sections 1 and 2). The total thickness of this limestone band, as calculated from the angle of dip, would be 1,399 feet, taking an average dip of 45°.

25. Passing through this gap we emerge on wide flats, composed in parts of fine alluvial clay and in others of coarse quartzose gravels. Although the usual character of this country is flat, it forms very rough travelling ground, being much cut up by dry gullies which doubtless in the winter season would form serious obstructions.

26. These flats have been formed by the mighty rush of water that has from time immemorial forced its way through the pass just described, and which has cut through the solid rock for a distance of about $\frac{3}{4}$ mile. During a wet and flooded season it must be a magnificent sight to behold the river rushing down between the rocky walls, which at the entrance are not more than 350 to 400 feet apart, and then augmented by the waters of a few tributary streams which flow laterally into the ravine, spreading itself out over the plains below. That such a rush of waters is not uncommon is shown by the quantity of recent drift-wood lying amongst the branches of trees 25 to 30 feet above the river bed; and at such times all communication must be cut off between those on either side of the range, unless some other passes, not subject to floods, exist, but with which we are not acquainted at present. For various views in this gap *see* Plates 18 and 19.

27. Coming down with irresistible force, the waters have carried with them enormous quantities of quartz, gravel, and fine silt from the metamorphic country, and these are strewn for many a mile over the Devonian slates, which form the bed rock of the valley below this pass.

28. On each side of this valley high hills arise. To the westward is the Albert-Edward Range, from this aspect sloping gently towards the vale; to the eastward are rugged hills of the same formation (Devonian)—Eliot Range, which rises to a height of 1,543 feet.

29. Looking southwards from the point just referred to, a fine well-grassed plain is seen stretching away to the distant horizon (20 miles perhaps), where it is bounded by flat-topped hills, probably composed of sandstone, and in all likelihood a spur or continuation of the Albert-Edward Range. From the plain a few isolated hills emerge, one called Mt. Timperley, and a remarkable looking hill near the "Crater," showing a great thickness of shales and slates capped with grits and sandstones.

30. Rounding the northern extremity of Eliot Range, the valley was seen to be bounded to the eastwards by a high table-land of dark colored rock, which eventually turned out to be basalt of several varieties. This table-land rises very abruptly from the plains to a height of from 1,000 to 1,500 feet above sea level,* and 600 feet at least above the river flats. As it presents a very similar appearance to the basaltic plateau of the North of Ireland, I have named it the Great Antrim Plateau. It has been traced for more than 100 miles, as mentioned in my preliminary report. The principal heights in this plateau are J 32 1,463 feet, Mt. Napier 1,294 feet,† and J 42, near Mt. Close, 1,489 feet.‡

31. The general appearance of the Antrim Plateau, as viewed from any commanding point on it, is that of a gently undulating series of rounded hills, with here and there a rough scarped face of rock, and now and then a deep well-marked valley. From some points of view the eye travels over an apparently interminable flat, only broken by a few isolated conical peaks. To the extreme North of this range, however, its character changes, and the outline of the country there exhibits a very rugged succession of high conical and truncated conical hills. This part of the district I was not able to visit, having other work in hand; but Mr. H. F. Johnston, who erected a cairn on a hill $15\frac{1}{2}$ miles N.E. of our last Camp on the Ord (marked J 42), informed me that for miles in every direction—in fact as far as he could see—the character both of rock and contour of the ground was the same.

32. From what I have seen of this plateau, I have estimated its area to be at least 3,000 square miles. Characteristic views of this portion of the country are given on Plates 4 and 14. The rocks belong to the Devonian period, as will be shown further on.

33. "Apart from the scientific interest attaching to the discovery of such an extensive flow of volcanic rock of that period, there is the practical importance due to the fact that, although this great plateau is for the most part composed of almost bare rock, it is well covered with various varieties of soft grasses and edible shrubs, even to the summit of the hills, and will afford excellent pasturage. This is due to

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* In my Preliminary Report I estimated the height of this Plateau as 2,000 feet above sea level; but at the time that was written the necessary calculations had not been made.

† After His Excellency Sir F. Napier Broome, K.C.M.G.

‡ After my friend the Revd. Maxwell Close, F.G.S., lately Pres. R.G.S.I.

the fertile nature of the soils produced through the decomposition of basaltic rocks; a fact which is well exemplified in other parts of this Colony, and is so well known that it need not here be enlarged on*."

34. As shown on the map, this plateau forms a rough semicircle, one end of which rests on the metamorphic rocks of the Ord, while the other reposes on the Devonian of the Elvire; enclosing the carboniferous rocks, which are seen in many places to overlie it.

35. It is not unlikely that the masses of basalt so frequently met with by Gregory in the neighborhood of Sturt's Creek, and extending for a considerable distance on his track to the North-west of the Creek, are continuations of the Antrim plateau†.

36. Minor ranges and hills are Dixon range,‡ with a height of 1,394 feet, North of the Panton River near its junction with the Ord; Hardman Range,—an isolated rugged sandstone range to the South of the same river—which rises abruptly from the plains, and extends South-east for about 10 miles, its greatest elevation being 1,326 feet; J 38 is a limestone hill capped with agate, rising to a height of 1,458 feet; and J 39 marks a rather extensive range of sandstone hills, to the North of the Ord River, which rise to a height of 1,662 feet. These hills, the formation of which is carboniferous sandstone and grits, are extremely rough and much cut up by deep ravines and gullies, which render their ascent very difficult. Their southern aspect is very steep and precipitous, and it was not without considerable labor that, by means of a steep and rugged gully, the summit was reached. From this a view was obtained of a wide plain stretching away to the North-east, from which rose three isolated rock masses. One of these, resembling an ancient square tower, is composed of various alternations of sandstone and grits, and elevates itself to a height of 400 feet sheer, above the level country ||. *See* Plate 5. It is called Mt. Glass, and the intermediate one Mt. Buchanan.

37. On the other side of the Ord, and about 25 miles to the N.E., is a low range of hills trending N.W. and S.E. for 12 or 15 miles. The northerly extremity of this has been named Mt. Elder by Mr. A. Forrest,§ but the highest point lies near the S.E. extremity; it is marked on the map as J 40, and is 987 feet above sea level. The main portion of this range is composed of carboniferous rocks, chiefly sandstone and grits, with ironstones, capping the limestones of the flat country beneath; but at the summit of J 40 there is a small patch of white limestones, soft sandstones, and chert, the last containing quantities of a gasteropod shell, which Prof. McCoy, of Melbourne University, has determined to be a new species of *Planorbis*, and which he has named *Planorbis Hardmani*. This small outlier, which rests unconformably on the carboniferous rocks, must be therefore of Upper Tertiary age, and is the only remnant of a formation, which probably, formerly widely overspread this district, but has been long since removed by the forces of atmospheric denudation,—in this country of tropical rains and intense heat, exceedingly powerful.

38. To the North and eastwards of this range the country is very rugged in character, consisting of low hills, sometimes rising perhaps 400 or 500 feet above the general level. It is for the main part composed of red and yellow sandstones of Carboniferous age, and in some places, even on the lower bends, is weathered and denuded to such an extent as to render travelling over it very rough work indeed. Nevertheless it is very frequently well, and occasionally luxuriantly, grassed; a fact which we attributed to the probability of there being a better rainfall in this higher inland district, surrounded by extensive hills and plateaus, than in the country nearer the coast, where hills of sandstone of precisely the same character in every respect are devoid of any vegetation save a few stunted eucalypts, &c., and spinifex—(*Triodia Irritans*).

39. Eastwards of this sandstone country lies the Negri River, on the east side of which the carboniferous limestone comes in again, forming a kind of table-land stretching N. and S. and rising in successive terraces until it culminates in Mt. Panton, a very remarkable table-topped hill, elevated about 500 feet above the highest of the limestone terraces, and 1,150 feet above sea level. It is a very noticeable figure in the landscape, on account of its complete isolation from any other hills for many miles, and its almost castle-like shape. It is of small extent, however. A very good view of it and the terraced limestone country may be obtained from Mt. Napier to the southward.

40. The above description refers to only the more remarkable hills and ranges in the Kimberley district, for the purpose of giving a general idea as to the contour of the country. The following Table of Heights above sea level may prove of use for comparison with the accompanying Map. As before mentioned, they can only be considered approximately correct. Unfortunately the Boiling Point apparatus we brought with us met with an accident and could not be used.

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* Preliminary Report, 1884, E. T. Hardman.

† Journal of Australian Exploration, by A. C. & F. T. Gregory, Brisbane, 1884, p. 144, *et seq.*, and 169; where the basaltic range is stated to have an elevation of 1,300 feet above the sea.

‡ From the summit of this hill we obtained our first view of the Ord Plains. *See* Plate 12. || Information received from Mr. W. Button, Manager of the Ord River Cattle Station.

§ Report on North-West Exploration, Journal of Expedition from DeGrey to Port Darwin, by A. Forrest, Esq., F.R.G.S.

Table of Heights in Kimberley.

	Above Sea Level. Feet.
Derby	17
Margaret River near Leopold Range	445
F 139 (under Mt. Huxley)	757
Mt. Huxley	1864
Margaret River at Gorge (near J 11 and Mt. Bertram)	691
J 10	1649
J 11	1006
Mt. Bertram	1238
Mt. Malcolm	2500
J 13	1190
J 17	1027
J 18	1373
J 19	1468
J 21 Ramsay Range	1463
Camp, Margaret River near above	911
J 22	1844
Mt. Maitland	1469
Rock Hole Camp	1000
Syenite Camp	1019
Near Laugher's Camp	1226
Plains S. of Mt. Barrett	1318
Hills S.W. of Mt. Barrett	1525
Mt. Barrett	2216
Divide, or Watershed between Ord River and Margaret River	1325
Do. do. further North	1400
J 25	1555
J 26 Camp on Elvire River	1288
J 27	1605
Crater Camp	807
Crater edge	1170
J 29 Eliot Range	1543
J 30	1593
J 30 Camp, Elvire River	740
J 32	1463
J 32 Camp, Elvire River	598
J 34	1650
J 34 Camp on Panton River	649
Mt. Coghlan	2062
Mt. Coghlan, Camp beneath (2 miles N.E.)	1228
Base line Camp (bed of Panton River)	565
Hardman Range	1326
Dixon Range	1394
Agate Hills, J 38	1458
Camp, River Ord to N.W.	585
J 39	1622
Plains beneath J 39	1003
Camp on Ord, Z 31	456
Ord River Cattle Station	486
J 40 near Mt. Elder	987
Ord River W.S.W. of above	371
Last Camp Ord River about 25 or 30 feet above river bed	363
Mt. Deception, Ord River	905
Mt. Panton	1150
Mt. Napier	1294
Last Camp on Negri River between Mts. Panton and Napier	612
J 42 near Mt. Close	1489

41. *Watersheds.*—The main watersheds of the country must be considered to lie in the Leopold and Mueller Ranges, where so many large rivers have their source. In this especial district, however, the principal watershed is that which divides the waters of the Ord River from those of the Margaret. This was crossed about 5 miles South of Mt. Barrett, in Lat. 18° 16′ S. and 127° 37′ E. Long. It extends in a N.N.E. and S.S.W. direction, and at the points crossed was 1,400 and 1,325 feet respectively above sea level. The general rise of the country being so gradual the divide itself is hardly appreciable, but from the one side of it flow the Elvire, the Panton, and the Ord, and from the other the Margaret, with its many tributaries.

42. *Rivers.*—The district is for the most part well watered, there being many large streams with numerous smaller tributaries, creeks, and brooks, in which can always be found, even in the dry season, good water pools within reasonable distances. These streams, with their tributaries, concentrate themselves into two main rivers: the Margaret River, which, joining the Fitzroy below the Leopold Ranges,

flows finally into King's Sound on the western coast; and the Ord River, which, flowing in a general N.E. to N. direction, falls into Cambridge Gulf.

43. Tracing the Margaret upwards, it is found to emerge from a deep gorge in the Leopold Ranges, where the rocks on each side rise in steep precipices, some 500 feet in height. Beyond this point the Surveying party did not penetrate but were obliged to skirt the Ranges, and the next point where they observed the river was 25 miles to the South-east, as the crow flies, where it enters the ranges. It is estimated, however, to travel for about 30 miles from this point through the gorge, a description of which is given in a Diary published by Mr. Durack, who penetrated it in the year 1882. The gorge takes a general northerly direction for about 8 miles, and is then supposed to continue for about 21 or 22 miles W.N.W. At the entrance it is about 5 chains (330 feet) wide, but varies much in this respect in many places, the river bed being as much as 8 to 10 chains in width, a short distance below the opening.* From the hills a little south, the river can be seen to cut its way deeply through beds of quartzites and schists for several miles; first to the N.E., then N.W., from which it appears to turn nearly North, as shown on the map, and disappears among the rugged hills of the Leopold Range.

44. Still following the river upwards it is found to increase considerably in width, but with a corresponding diminution of height of bank, and about 10 miles from the gorge it attains the breadth of about a quarter of a mile.

45. The river bed at this locality (and the same description will apply to many of the other rivers in the district during the dry season) resembles a very wide sandy avenue. This appearance is, however, often varied by the introduction of sand banks luxuriously clothed with acacias of various kinds and cajeputs. Indeed, in many places, there is actually more vegetation in the actual bed of the river than on the banks of it, and one may often ride through a miniature forest of such trees as the above, in the centre of a large river bed.

46. From this point the river bed diminishes gradually in size, but is still of no mean dimensions. Taking a sharp sweep to the southward, it then bends to the East, and at about 30 miles from the gorge in the Leopold Ranges, bifurcates; one branch running from the northwards, the other coming in from the eastwards.

47. The former is considered to be the main branch of the Margaret River, and there can be very little doubt that it is the continuation of the river flowing nearly S.S.W. in Lat. 18° S. and Long. 127° 32′ W., about. This portion of the river was traced by Mr. O'Donnell for about 75 miles from its source, and he describes it as emerging from high sandstone ranges and deep gorges.† Its course from this point to within 10 miles of Ramsay Range, where it is seen flanking the granite ranges, is somewhat uncertain, but the indication shown on the Map must be in the main fairly correct.

48. Altogether this river has been traced, from its source to its junction with the Fitzroy, for about 235 miles, which, added to the Fitzroy below the junction, gives a total length of river of about 425 miles, rough measurement.

49. Its chief tributary is the Mary River, which takes its rise to the North of the McClintock Ranges, and flows in a general W.S.W. course for about 60 miles, until it joins the Margaret at a point 20 miles S.W. of Ramsay Range. At this place the river bed is very wide, 250 yards (10-12 chains), and it was difficult to determine at first which was the main branch, but this was afterwards conclusively decided. Twelve miles higher up a small tributary called Laura River flows south-westerly into this stream. It has been traced for about 10 miles. It is about 4 chains (90 yards) wide, where it joins the Mary.

50. A short distance above the junction of the Mary and Margaret rivers, the structure of the former becomes very complicated. The river bed is very thickly timbered and spreads into numerous channels of which it is impossible to define the main one. The total width of the river bed here is 25 chains (550 yards). This is a character, however, presented by all the rivers in the district, where at one season there are heavy downflows of water, while at another the river bed is almost, if not entirely, dry.

51. Another tributary of the Margaret enters it about 5 miles South of the Mueller Range Gorge, coming in from the N.E. past Mt. George. It has been traced for about 30 miles in that direction by Mr. Alex. Forrest, who considered it to be the main river. It is of no great width, however.

52. About 12 miles below the Leopold Range gorge, nearly opposite Mt. Krauss, a large tributary falls into the Margaret from the S.E. It is several chains wide, has been traced for more than 25 miles, and has been named the Louisa River, after my wife.

53. Numerous smaller streams serve to swell the above rivers, and usually contain in the dry season very welcome supplies of water in rock holes and small pools.

54. The configuration of the country through which the Margaret and its tributaries pass varies very considerably. They sometimes flow between wide plains of alluvium, often well grassed; and again,

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* About 2 miles was the furthest point which I was able to reach in this opening: see *post*.

† Diary of Exploring Expedition led by Mr. W. J. O'Donnell, from Port Darwin to Cambridge Gulf, 1884, pp. 15, 16. Printed for private circulation.

they cut their way through hard granitic and metamorphic rocks, which crop out of the surface for miles around. Those features will be referred to more fully in the "Detailed Description" further on.

55. The next river to be described is the Ord River. This, which is for many reasons the most important river in the Kimberley District, was discovered by Mr. Alexander Forrest, during his toilsome and valuable exploration of 1879, and named by him after Sir Harry Ord, the then Governor of Western Australia. Owing to illness amongst his party, and want of provisions, he was unable to follow this fine river further down than a distance of about 125 miles from its North-western branch, where he first observed it. He suspected it, however, to flow into Cambridge Gulf, and this prediction was confirmed a few years after, when, in 1883, Mr. O'Donnell explored this district, and mapped the general course of the river from the point where Mr. Forrest was obliged to leave off, to Cambridge Gulf, a distance, according to Mr. O'Donnell's map, of about 225 miles. The length of this section of the river, therefore, will be 350 miles, and Mr. O'Donnell describes it as being 3 miles wide where it falls into Cambridge Gulf, near Quoin Hill.*

56. As the survey party ceased work on this river about the same point where Mr. A. Forrest left it, I cannot give any description of it below this, except to say that it evidently enters a very rough mountainous country, formed of metamorphic rocks (*see* Plate 25), and doubtless is consequently considerably contracted in width;† but the principal part of the river which we traversed is of great width in places, and averages about 12 chains wide, but it often widens out to as much as 20 or 25 chains (550 yards). This part of the river flows between very high banks of alluvium, in some places as much as 50 feet high, overlying soft micaceous sandstones, probably of Carboniferous age.

57. The Ord is augmented by several large tributaries. One of the principal of these, is the Elvire,‡ an important river discovered by the survey party of 1884. It takes its rise about 9 miles S.E. of Mt. Barrett, and not far from the crest of the dividing range (4 or 5 miles), and travelling nearly eastwards for about 20 miles passes through the gorge in the Albert-Edward Range, previously described; then, after a sharp bend to the southwards, turns to the northwards and follows a general N.N E. course for about 35 or 40 miles, when it joins, or is joined by, the Panton River, another affluent of the Ord. From this point the river course, proceeding as far as the Ord, has been considered part of the Panton, and continues for about 22 miles to its junction with the Ord.

58. I am of opinion, however, and the surveyors of the party agreed with me, that this portion of the river should be regarded, strictly speaking, as a portion of the Elvire, and that the Panton is really only a tributary of that river.

59. Moreover, I consider that the Elvire itself is in reality the true source and upper water of the Ord River. Its length to where it joins the Panton is considerably more than that of the latter to the same point, being 65 miles as against Panton—35-40; and the so-called Ord, as traced by O'Donnell from its source to the "junction," is but 40 to 45 miles. Therefore, for superior length, it must be considered the main branch of the Ord, while as to width it is at least as wide as the Panton at their junction; and its general direction for the greater part of its course coincides with that of the Lower Ord. Add to these considerations that at least two very large tributaries fall into it from the South and South-east, one to the East of Albert-Edward Range, and the other to West of it, both, from their size, evidently draining a large area of country to the southward. On the whole, therefore, the Elvire must, I think, be regarded as the main source of the Ord, and the other branches, viz., the North-western Ord and the Panton River, to be merely affluents: tributaries flowing from the high hilly country to the West and North-west.

60. The total length of the Ord, including the Elvire as its upper portion, is accordingly at least 370 miles.

61. The upper portion of the Elvire, which commences its course as a very small brook, but widens in the distance of some seven miles to be a noticeable river bed,—passes for some 15 miles through an extremely rough rocky country, winding its way in a most intricate manner amongst the metamorphic hills. On one side or other of its course are high hills or steep cliffs often 200 or 300 feet high, and it often passed through deep narrow gorges which in the dry season are only just penetrable, but during the winter rains must be impassable. One of these passes was called "Caroline Pool," after one of our mares, who slipping off the narrow ledge of rock by which alone we could pass a very deep pool hedged in on every side by steep rocky walls, tumbled in and persisted in remaining in the centre of the pool until one of the men swam out and towed her ashore. She was loaded with about 200lbs. weight of flour and other *impedimenta*, and it was a marvel to us that she escaped.

62. So close did the rocks come to the water at this place, that we were obliged to spend a considerable time engineering, and preparing a road by which the horses with their loads could pass. *See* Plate 22.

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* See Report by Staff Commander Coghlan, R.N., Published by Authority, 1885. Also by Mr. O'Donnell already cited, and Mr. Alex Forrest, *supra cit.* Commander Coghlan states: That the river narrows where the boat navigation ceased, in September, 1884, about 10 miles above Quoin Hill, to from 30 to 50 yards. *Supra cit.*, p. 7.

† In fact where we left it was seen to be gradually becoming narrower.

‡ Named after Mrs. John Forrest.

63. After passing through the Albert-Edward Range the character of the river scenery completely alters, and instead of narrow gorges and ravines there are wide-spread alluvial flats and fertile plains extending for miles on each side of the river, where they are bounded by high sandstone and limestone hills. In some few localities rough limestone and sandstone rocks crop out for some distance along the river banks, but this is not a usual feature. To the South of the "Crater Camp" the plains extend for many miles, and at 10 miles to the N.N.E. there are splendidly grassed plains about 9 miles in width from hill to hill. The bed rock here is slate of Devonian age which frequently crops out, and as it is important to show the different members of this formation, I have omitted on the map the coating of alluvium and gravels which for the most part covers it.

64. The general character of the river valley is now much the same, except that it is wider or narrower in places, down to the junction of the Panton.

65. This tributary flows from the westward in a generally parallel direction to that of the first part of the Elvire, and through a similar formation, viz., the metamorphic rocks, consisting of gneiss, and schists of various kinds, with quartz veins. Mr. G. R. Turner, second in command of the Expedition, who travelled through it with his party, described it to me as being rough in the extreme; the river cutting deeply into the hard rocks, and forming gorges the floors of which were composed of bare irregular masses of rock, rendering the passage of horses almost impossible. So rough was this river-bed that Mr. Turner could only succeed in making 4 miles a day!

66. The country through which this river cuts its way is shown in the Panoramic view (Plate 13) taken from the high sandstone range (J 34), overlooking the Panton.

67. The next tributary of the Ord to be noticed is the Negri, discovered by Mr. A. Forrest, and named by him after Baron Negri of Turin. This river has been traced for some miles to the S.E. of Mt. Napier, and flows in a general N.N.W. direction for some 40 miles, when it sweeps round to the West and falls into the Ord close to our camp on that river, in Lat. 17° 3′ S., and some 130 miles from Cambridge Gulf.

68. Like the greater number of the rivers in this district, it has a wide sandy bed (often 5 to 6 chains) enclosed between high banks of thick alluvium, beneath which are sometimes exposed thick beds of sandstones, shales, and limestones. In the dry season it contains deep pools of good fresh water.

69. At its junction with the Ord, however, the water is quite salt, and a thick incrustation of that substance covers the rocks along the margin of the stream. The same circumstance was noticed for two miles down the Ord below this point, where the water improved in quality, although still distinctly brackish, salt also appearing on the rocks. Salt water was also noticed in the Ord river, a few miles above the junction of the Negri, by Mr. Turner, and the same phenomenon has been remarked previously by Mr. A. Forrest when travelling near this locality.

70. The Negri is fed by a few small tributaries, one of which is supposed to be the continuation of the Stirling Creek. Another, which flows from the North-west of Mt. Panton, has been named Nelson Creek by Mr. O'Donnell.

71. Minor tributaries of the Ord are Nicholson River, Linacre River, and Forrest River, which flow into it from the southward a short distance below the "junction" of the Ord and so-called Panton ? Elvire, and within a few miles of each other. The Nicholson, which is the largest of these, has probably a course of 25 miles. None of these streams have been traced to their sources, however.

72. For the greater part of their course the Ord River and tributaries have their banks thickly clothed with vegetation. Acacias of may kinds are abundant, and of these the beautiful "White Acacia" bearing a very handsome papilionaceous flower is the most remarkable, and often attains a large size, affording a most welcome shelter from the tropical heat. Cajeputs often grow to an enormous size, and white gums have been noticed at least 3 feet in diameter. A very beautiful Fan Palm has been noticed in several localities along the Elvire River, sometimes attaining a height of 70 feet; indeed one valley exhibited such a fine grove of these trees, that it was named "Palm Valley."* The Water Pandanus or "Screw Pine" is tolerably abundant on the Ord, but does not grow so luxuriantly as on the Fitzroy; and bamboos, but of a small size, grow very thickly in places. In one place on the Negri we observed canes in all respects resembling the sugarcane. The Calubar, a Queensland tree resembling the red gum, is also common along the banks of some of the smaller tributaries.

73. On the river flats and in the interior are many varieties of trees familiar to Queenslanders. The Bauhinias or Rosewood tree; the Beefwood, with its remarkable rush-like, or in some cases ribbon-like leaves; the Bloodwood; the Curry-John, and the so-called Chinese Cedar, a deciduous tree bearing a winged seed like that of the common English Ash.

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* This palm was first noticed in the gully at the entrance of Straith-na-diaoul, near Mt. Huxley.

LIST OF GEOLOGICAL FORMATIONS, WITH GENERAL DESCRIPTION OF SAME.

Geological Formations.

AQUEOUS ROCKS.

Recent.

1. Alluvium ... ...
   River Gravels ... ...
   Soils when largely deposited, colored as above ... ...

Recent or Pliocene.

2. "*Pindan*" Sands and Gravels, Ironstone conglomerate, &c. ... ...
   Boulder Gravels of the Louisa River ... ...

Tertiary ? Pliocene.

3.—Limestone, soft sandstones, and Agate beds, with *Planorbis Hardmani*

Carboniferous.

4.—Sandstones, grits, and conglomerates, with ironstone ... ...
5.—Shales and mudstones ... ...
6.—Limestone ... ...

Devonian ?

7.—Shales and indurated slates ... ...
8.—Limestones ... ...
9.—Coarse grits, sandstones, and conglomerates ... ...

METAMORPHIC ROCKS.

10.—Schists, slates, gneiss, granite, &c. ... ...
11.—Quartzites and altered grits ... ...

IGNEOUS:—*Volcanic* (*probably Devonian*).

12.—Basalt, Dolerite, &c. ... ...

IGNEOUS:—*Plutonic* (*Post Silurian.*)

13.—Granite, Syenitic Granite, Syenite, &c. ... ...

INTRUSIVE.

14.—Basalt and Diorite in dykes ... ...

For character and colors by which these are defined, *see* the List on Map.

GEOLOGICAL AGE.	CLASSIFICATION OF ROCKS.
Recent.	*Alluvium.*—Wide plains along the rivers, often extending some distance into the interior. *River Gravels.*—Along the banks and in the beds of rivers.
Recent or Pliocene.	*Pindan* sands and gravels, with consolidated beds of ironstone conglomerates. *Boulder Beds.*—Great masses of boulder gravel covering extensive areas in the neighborhood of the Leopold Ranges on the Louisa River.
Tertiary (? Pliocene).	Limestones, soft sandstones, and Agate beds, containing Planorbis Hardmani (McCoy), occurring near Mt. Elder.
Carboniferous.	*Sandstone.*—Sandstones, grits, conglomerates, and shales, with numerous bands and nodules of ironstone. *Limestone.*—Variously colored hard compact limestones, with beds of agate and jasper. Very fossiliferous in places and containing Gypsum, Calcite, Lead and Zinc Ores, and Carbonate of Copper.
Devonian.	Coarse Grits and Sandstones; Limestones, with beds of agate, calcedony, &c., and shales; all showing more or less traces of Metamorphic action.
Lower Silurian or Cambro-Silurian. (*Metamorphic*)	Quartzite and Altered Grits Mica Schist Talc Schist and Slate, Chlorite Schist Andalusite Schist Hornblendic Schist, Quartz Schist Gneiss Granite Porphyritic Diorite
Igneous:—Volcanic Of Devonian Age.	Basalt, Dolerite, Trachy-dolerite, Lava, Ferruginous-Wackenite, Volcanic Breccia, &c., in sheets and flows.
Igneous:—Plutonic (Post Silurian)	Granite Syenitic-Granite Sinaite Syenite Porphyry Syenite.
Intrusive.	Diorite and Basalt in Dykes.

74. *Alluvium Soils and River Gravels*:—This clayey deposit, resulting from the accumulation of silt and sand carried down by rivers, and forming the river flats, is in some places a not unimportant formation, but it is not so widely spread nor so noticeable as in the district described in last year's Report (including the May, Meda, and Fitzroy rivers), owing to the peculiarly hilly conformation of the

country referred to in this memoir. We cannot trace, on any of the rivers under present notice, alluvial plains 200 miles long and averaging 6 miles wide, as on the Fitzroy; still in many places there are to be met very extensive flats of alluvium, sometimes several miles wide and of considerable thickness.

75. On the Lower Margaret these flats often extend for miles away from the river, and are sometimes well grassed; although it now and then occurs that, while the soil looks particularly good and rich, there is little or no vegetation.

76. To the westward of the Leopold Ranges, on the upper reaches of the Margaret, there are occasional good wide patches of alluvium, and on the main branch coming by Ramsay Range there is an alluvial flat about 15 miles long, and averaging about 2 miles wide.

77. On many of the tributaries of the Margaret there are thick beds of alluvium occasionally spreading out for a few miles. They are, however, generally of such limited extent that any attempt to delineate their boundaries on a map of the small scale as that which accompanies this Report would only lead to confusion.

78. Passing on to the Elvire we met with some fine stretches of alluvium just at its source. These are in places 3 to 4 miles wide, and about 10 miles long. Below this point there are a few narrow flats, and then nothing worth noticing is seen of alluvial deposits until the portion of the river below the gorge in Albert-Edward Range is reached. From this point downwards to the junction of the Panton River, extensive alluvial flats are seen at intervals, and in places this deposit is very thick. At the "Crater Camp," S.W. of Eliot Range, the alluvial deposits are often 50 to 60 feet thick, and so cut up by deep gullies, or "billabongs," as they are sometimes erroneously termed, as to render travelling on horseback not only difficult but dangerous.

79. Along the Elvire the alluvial deposit is for the most part very irregular, and is frequently broken by the out-cropping of Devonian slates. For this, and the reasons already stated, I have not specially colored it on the map, except in one or two well marked cases. The lower part of the river, however, near where it joins the Ord (that is, according to previous explorers, the Panton), flows through very wide and thick alluvial flats, which spread out for some miles on each side of the river, and are continued down the Ord River to its junction with the Negri.

80. Along the western side of these rivers from the point mentioned the alluvial is tolerably well defined, and is known to extend from the river bank for a distance of from 2 to 4 or 5 miles. Here it is terribly cut up by gullies, often 60 feet deep, and near the junction of the Elvire (or Panton) and the Ord, these are so numerous as to render the ground a perfect labyrinth, as I once discovered when endeavoring to ride over it one evening after dark.

81. On the eastern side of the Ord the alluvium extends for a considerable width, but it is impossible to define exactly its limits, as it merges gradually into a very similar looking deposit, which is clearly a soil and not the result of a river flood, because the ground, although apparently flat, really rises with a rapidity inconsistent with the belief that the waters which deposited the clays forming the river flats could have covered it. These soils are no doubt the result of the washing down by *rains* of the disintegrated portions of the rocks forming the high ground to the eastward. They form some of the richest ground in the district, are generally of a chocolate or dark brown color, and are magnificently grassed; the well-known Mitchell Grass, so highly esteemed by sheep owners, being plentifully met with. The Ord Plains, including the alluvium and soil, are often 15 or 20 miles in width; Plate 12 gives a view of these extensive flats as seen from the summit of Dixon Range, from which spot we obtained our first view of the Ord itself, which is seen wending through the plains, its course being marked out by a wide band of thick timber.

82. There are also extensive well grassed flats which have no apparent connection with large rivers. They owe their formation, doubtless, to the same cause as that suggested in the case of the Ord soils, namely, the wash of rains during the wet season, which, denuding the rocky hills, rush down, and, spreading out over the low ground, deposit year by year their proportion of sediment.

83. Among the most noticeable of these flats are those known as the Nicholson Plains, which extend for about 12 miles to the North of Mt. Barrett, and for 5 miles to the South-east of it, having a total length of nearly 20 miles, and a breadth of 15. They are for the most part well grassed, and lie in a kind of basin amongst granitic, quartzose, and sandstone rocks.

84. Another very extensive plain is seen to the North-east of J 39, not far from the Ord. Its area has not been ascertained, but, judging from the view obtained of it from the hills, it must be very great, and considerably more than that of the Nicholson Plains. It seems to be partly made up of soil, with sandy patches here and there. It is remarkable for the peculiar appearance given to it by the three isolated rock masses already referred to (*see* Plate 5) towering aloft from the flat surface.

85. South of Mt. Barrett, plains of the same description and formation are met with frequently, and sometimes are of large extent, affording excellent pasturage.

86. *River Gravels.*—These are chiefly developed on the Margaret River below the Leopold Range, as mentioned in last year's Report, on the Elvire below the Albert-Edward Range, on the Panton near its

junction with the latter, and on parts of the Ord. On the Margaret they are composed of large rounded and water-worn pebbles and boulders of quartzite and altered grits, brought down from the Leopold Ranges, but are of no great thickness. On the Elvire, Panton, and Ord they are made up of fragments of metamorphic rocks together with great quantities of quartz, all more or less showing the result of water carriage. In these latter rivers the gravels along their banks are often from 20 to 40 feet in thickness, and wherever they have been prospected have yielded good colors of gold; a fact which is easily understood, when it is known that they are the *detritus* of the quartz-bearing schists and slates to the West of the Albert-Edward. Thick deposits of such gravels are sometimes found extending for more than a mile on each side of these rivers, and not seldom to a much greater width. A few miles below the "Crater," for instance, the river banks are for miles formed of these quartz gravels, which are, here, from 2 to 4 miles wide.

87. On the Ord this quartz gravel has been noticed for more than 50 miles from the chief entrance of the river through the Albert-Edward Range.

88. Similar coarse gravels, but not always quartzose, were noted along the margins of many of the smaller rivers, and sometimes of very considerable thickness. In one place S.E. of J 19 (Lubbock Range) a small stream cut its way through a deep valley, and there are exposed cliffs of gravel fully 30 feet thick. Here it is consolidated into a coarse conglomerate, and shows distinct lines of stratification. Masses of it had fallen down into the valley, reminding me of similar blocks of conglomerate occurring in the river at Jenkinstown, county Kilkenny, Ireland,* with the difference, however, that those gravels are of glacial origin.

89. These great thicknesses of coarse bouldery gravel seem to denote that at some not far distant time the rainfall of the Kimberley District must have been very great, and that immense seething and tumultuous floods, far in excess of anything of the kind at the present day (although we know that even now overwhelming floods devastate the country, at long intervals perhaps), rolled down from the higher grounds, tearing away masses of rock, grinding them up, and depositing them along the lower river valleys.

90. *Hill Gravels and Boulder deposits.*—The summits of many of the higher hills in this portion of the Kimberley District are partially or often completely covered by quantities of boulders and pebbles, all more or less rounded. It is difficult to understand how such materials could be conveyed by water to the tops of hills, sometimes more than 500 feet above the neighboring valleys, and at first sight it is equally difficult to account for their presence in any other way. On careful examination, however, it will be found that, without exception, the pebbles and boulders are composed of the same rock as the hill itself. And the only conclusion that can be come to is that they were weathered into their present shape and condition on the hill itself. This is easily conceivable when we recollect the tremendous force of the tropical rainfall, combined with great alternations of temperature, leading to equally great alternations of expansion and contraction; the latter producing cracks in various directions according to the character of the rock; water then performs the work of rounding off the asperities, and producing a simulated gravel.

91. In a part of the district the granite is weathered in such a way as to suggest glacial action, and sometimes on sharp pinnacles are supported "perched blocks," in every way resembling those with which we are familiar in glaciated countries. But there can have hardly been such action here in the tropics, and we can only account for the presence of these perched blocks by the action of local denudation. In the same way the formation of the pseudo-gravels, just described, may be accounted for.

92. "*Pindan*" *Sands and Gravels.*—These, which are named in consequence of their occurrence chiefly in the wooded country which the natives term "Pindan"—are very conspicuous in the country described in last year's report; but have been rarely met with in that visited during the last expedition, and only in small patches, principally on the lower part of the Margaret, although they have been noticed in places on the higher levels of the Ord River flats and also on the Negri. They consist of red and yellow sands, and gravels with quantities of small pea-like pebbles of brown iron-ore evidently derived from the older rocks. Intimately associated with them are thick beds of consolidated ironstone conglomerate, sometimes containing a large proportion of quartz pebbles, and often assuming the form of low flat-topped and conical hills, as, for example, in the neighborhood of J 18, and between Syenite Camp and Ramsay Range.

93. It is difficult to assign a geological age to these deposits, but it is certain that they do not belong to a very remote epoch. Last year I provisionally classed them as Pliocene; however, it is possible that they are really of later date, as they seem to dovetail, in some instances, with the river Alluvium.

94. No fossils of any kind have yet been discovered in them.

95. In the district under notice their thickness is inconsiderable, rarely more than 10 to 20 feet, and seldom even reaching so much.

96. *Boulder Gravels* of the Louisa River.—To the South-west and South of the Leopold Ranges (Mt. Huxley) are a series of rounded hills already referred to (p. 3) composed of immense quantities of large

* Memoir on the Geology of the Leinster Coal Fields, by Edward T. Hardman, Dublin, 1881, p. 17.

pebbles and boulders, the latter often exceeding 2 feet in diameter. These hills extend in a general direction to the E.S.E. for 25 miles, but the ridges of which they are made up appear to have a distinct trend N. and S.

97. At J 8, a trigonometrical station 8 miles to the South-west of Mt. Huxley, the height of these hills was 525 feet above our Camp in the valley under that hill, or 1,282 feet above sea level.

98. The composition of these Boulder Beds is curious. The pebbles are for the most part of quartzite, and altered grits of various colors (grey, green, and red), together with purple conglomerates, all highly indurated and apparently metamorphosed. A few blocks of quartz also occur, as well as some rounded fragments of Basalt, and, rarely, large blocks of granite.

99. The nearest locality from which these rocks could be derived is the southern end of the Leopold ranges. They are not local rock, as the underlying rock has been ascertained to be sandstone, grits, and limestone of the Carboniferous period, and of quite a different character and appearance to those forming the mass of this boulder gravel. These carboniferous rocks are seen cropping out in several places from beneath the drifts, which are in many places at least 30 or 40 feet thick.

100. They are therefore not local, nor could they have been transported by river action seeing that they form a series of rough hills more than 7 miles in lateral extension in some places, and of a very irregular shape.

101. The true explanation is probably this:—That at one time, not very remote—perhaps the Pliocene period—this district was covered by a sea, remarkable for high and rapid tides and strong currents. The carboniferous rocks formed prominent reefs in that sea; and these boulders, originally torn from what are now the Leopold Ranges, and tossed about in this troubled water, until they were rounded into the forms in which we now find them, were finally rolled away by powerful currents and tidal influences, and deposited against and on the carboniferous reef. The general form of the gravel ridges and the nature of the deposit, which, when a section is exposed, is seen to be more or less stratified, goes far to favor this supposition.

102. *Upper Tertiary ?Pliocene.*—Near Mt. Elder, about 15 miles from the junction of the Ord and the Negri, is a hill, marked on the map as J 40, where there are beds of soft red and white sandstone, with chalky concretions, succeeded by hard white limestones, and these capped by thick beds of agate and flint. These last beds are remarkable for containing myriads of a fossil gasteropod. Some specimens of this I sent to Professor McCoy, of the Melbourne University, for identification, and he pronounces it to be a new species of *Planorbis* of Upper Tertiary Age. He has named this fossil *Planorbis Hardmani.*

103. The rocks in question occupy but a small area and rest slightly uncomformably on the underlying carboniferous rocks; they are about 150 to 200 feet in thickness.

104. *Carboniferous Rocks.*—These are widely represented in the Kimberley District. They were traced during the expedition of 1883 over a great extent of country, and have this year been followed up for many miles further in the interior. The formation here consists of limestone of various descriptions (with beds of agate, jasper, and calcedony), sandstones, grits and conglomerates, and mudstones or sandy shales. The sandstone division contains great quantities of ironstone, chiefly brown hematite mixed with magnetic iron ore, in bands and veins, and the same mineral occurs occasionally amongst the limestones.

105. *Carboniferous Sandstone.*—This, which includes the grits, conglomerates, &c., appears to be the uppermost member of the group. In the Fitzroy and the districts of the Meda and Lennard this was shown to be the case; and, although we have no continuous section showing the relative position of the limestone to that of the sandstone in the district examined, there can be little doubt as to that point, as the sandstones, &c., are in every respect similar to those of the carboniferous formation hitherto observed in the district, and, moreover, the limestone is invariably found resting on the Devonian basalt, while the sandstones as invariably occupy such a position as to make it clear that they always overlie the limestones.

106. The sandstone formation shows prominently in many of the hill ranges; besides those on the Fitzroy, it occupies a considerable portion of the Haughton Ranges, which extend for some 35 or 40 miles. It is next seen in the Ord District along the North-west of which it stretches for over 50 miles in length, with a minimum width of about 20. Here it rises into high ranges, of which Dixon Range and the hills marked J 39 are prominent examples. Hardman Range,* to the South, is also composed of it. Further North the strip of country extending from Mt. Elder along the Negri to the South of Mt. Panton is mainly composed of this formation, although occasionally subordinate bands of limestone are met with in these rocks.

107. The local character of these sandstones is very various, and it often happens that many different specimens, both in color and texture, may be obtained within a very small radius. The prevailing nature of the rock, however, is that of a yellow or reddish freestone, very soft in places, and susceptible to "weathering," owing to which the rock-masses often assume strange and fantastic forms, especially when,

* So named by Mr. Johnston.

as is often the case, these softer beds are intercalated with beds of a peculiarly hard fine-grained light grey grit. In the precipices, near J 39, some very extraordinary forms are the result of this "hard and soft" weathering. *See* Plate 5.

108. In other places the carboniferous sandstone is of a dark reddish color, and a coarse rough texture, and usually contains a considerable admixture of black oxides of iron (titaniferous or magnetic iron ore); thick veins of iron ore are common in it, as for instance in the country North and North-east of Mt. Elder.

109. Thick beds of an extremely hard close-grained grit, almost metamorphic in appearance, are also frequently met with, notably in a curiously formed valley near the station J 5, on Rough Range, where there is an isolated cone of this rock brought into its present position by a fault. Similar grits are found at the base of Hardman Range and in the hills to the S.E. of Mt. Elder.

110. We have not made sufficient examination to be able to estimate the total thickness of this formation; but in many places it is over 500 feet in thickness, and at J 39, on the Ord, it is considered to be 1,000 to 1,200 feet thick.

111. At the base of these sandstones, and appearing not far from the outcrop of the underlying limestone, are thick beds of chocolate colored sandy micaceous shales or "mudstones," in many cases from 75 to 100 feet thick, and these are often interstratified with, or rest on, hard thin flagstones. Excellent flags of large size may be seen in the bed of the river Elvire, about 7 miles below its junction with the Panton.*

112. Along the Ord the shales sometimes form high cliffs on one or other side of the river, from 30 to 50 feet in height. Similar shales are found on the Negri, also forming high cliffs; these, however, are of older date and belong to the limestone division, as will be referred to hereafter. In fact, in this portion of the district, the broad distinctions between the sandstones and limestones are not well marked, and although the prevailing rock is limestone in one place or sandstone in another, they interlace in such a manner that it is impossible to do more than indicate the principal member of each division on a map of so small a scale. In many localities colored sandstone and shale bands of limestone occur, and similarly in the limestones are frequently found beds of shale and sandstone.

113. The sandstone formation on the Fitzroy has proved to be very fossiliferous in several localities, and I have been fortunate enough to secure a quantity of very characteristic carboniferous fossils. That on the Ord has, however, proved very disappointing, not a single fossil having been obtained from it, although no pains were spared in searching likely places. However, a few fossils were discovered in the limestones.—*See* List of Fossils.

114. *Carboniferous Limestone.*—This is first noticeable in the ranges known as Rough Range, and extending to the South-east towards Haughton Range, a distance of nearly 30 miles. The extent of the limestone laterally, that is to the South-west, is not known, but in many places it is seen for 6 or 8 miles, and South-west of Mt. Huxley it stretches from its eastern edge, near J 8, for nearly 20 miles in that direction.

115. This ridge of limestone rocks is of an extremely rough character, whence its name. Although not greatly elevated—in no place appearing to exceed 300 feet above the neighboring plains—it is so worn into points, pinnacles, and gullies, that it is by no means easy to traverse. Proceeding up a seemingly inviting gully the traveller is soon stopped short by a solid wall of rock, and after much manœuvring to skirt this obstacle, finds that he is perhaps further from his destination than when he first set out. These rocks are of no great height, but being usually very steep, and weathered into a multitude of sharp edges which cut like knives, it is not only difficult but painful to clamber up them. On one occasion, when we erected the "trig." station J 5, I found the least difficult mode of ascent was to climb a tree, and from thence attain the summit of the cliff; returning I adopted the same means for exit. Mr. Johnston slid in a highly inconvenient and evidently painful manner along a sharp ridge of rock, and one of the men getting down with difficulty into a narrow chasm, found that his only means of egress was through a small hole in a wall of limestone, through which, after some efforts, he succeeded in forcing his body. As such experiences were not uncommon during our survey of this part of the country, the name Rough Range, conferred on it originally by Mr. J. S. Brooking in 1883, was considered not inappropriate. A view of the station referred to, in Plate 15, shows the general character of these ranges. For miles great masses and walls of limestone rear themselves above the surface, which is in many places covered with huge blocks, which have in the process of denudation been separated from the parent rocks, and the only vegetation is spinifex, with a few stunted bushes.

116. The limestone crops up at intervals between this range and Mt. Pierre to the northwards, a part of which hill is sketched in Plate 3, and is seen in various parts of the River Margaret, extending in rather high hills on the North of that river, both to the East and to the West (Hull Range, Mt. Krauss, &c.) The limestone, although continuous in this direction, has been denuded into a valley, and is for the most part covered by recent deposits and alluvium.

* All the rocks of this formation would afford good material for building and other purposes, and will no doubt be highly valued in the future, when the district is populated.

117. These limestones were partly described last year, and are in most respects similar in appearance and composition, taken in the mass, throughout the district. They consist in great part of rather massively bedded light grey and sometimes flesh colored limestone, often magnesian, but are interbedded with thin flaggy, earthy, and sometimes sandy limestones. But these chiefly occur amongst the lower beds, and are often interstratified with dark grey sandy shales. The valley of the Margaret is mainly composed of thin flaggy hard limestone (which gives a bell-like sound when struck with the hammer), earthy fetid limestones, and shales with nodular limestone bands.

118. The greater part of the limestone in this region is very fossiliferous. In several places in Rough Range, at Mt. Pierre, at Mt. Krauss, to the South of Hull Range, and in the rocks opposite to that hill on the South side of the Margaret, quantities of fossils of Carboniferous age were obtained, including sponges *(Stromatopora)*; corals of several varieties; *Annelids*, *Spirorbis*, and *Serpulæ*; *Polyzoa*, *Brachiopods*; *Lamellibranchiata*; *Gasteropods*; and *Cephalopods*. A few of these fossils are characteristic of the Devonian rocks, while others with which they are associated are as distinctly Carboniferous. This would denote, therefore, that these limestones belong to the Lower Carboniferous period, as it is not uncommon to find beds in the Lower Carboniferous, where fossils peculiar to both these formations intermingle to some slight extent: as for instance in the Lower Carboniferous rocks of Ireland, where in the county Cork true Devonian fossils are found along with the more characteristic Carboniferous fossils.

119. I have been able to compare these Kimberley fossils with a number of specimens brought down by Mr. Crossland, the surveyor in charge of the Gascoyne district, from the neighborhood of Mt. Kennedy. Fossils from this locality were sent to England by the Hon. John Forrest, C.M.G., Surveyor General for West Australia, and were proved to be of Carboniferous age by Messrs. W. H. Huddlestone, R. Etheridge, jun., and Professor Morris.*

120. On comparing the Kimberley specimens with those given me by Mr. Crossland, I find that in many instances the species are identical, including examples of Corals, Crinoids, Polyzoons, and Brachiopods. For instance, *Chætetes tumidus*, *Poteriocrinus Crassus*, *Fenestella Antiqua* (or *Plebeia*), *Producta semi-reticulata*, *Spirifera striata*, and many others.

121. As remarked in last year's Report, these discoveries show that there are wide-spread deposits of carboniferous rocks in Western Australia, although, even within the last few years, this has been doubted.†

122. From the localities just referred to, until the limestone of the same age is again met with, there is a distance of about 120 miles. A short way below the junction of the Panton and Elvire rivers limestone again makes its appearance, and occupies a wide area, extending as far North-easterly as for several miles beyond the Negri, in all about 75 miles, while in width it averages from 20 to 30 miles.

123. This portion of the limestone country rises in a succession of low and almost imperceptible terraces into high table-lands. One of these extends to the East of the Ord near the "Cattle Station," and another to the North and East of the Negri River, where it is capped by Mt. Panton.

124. The Ord limestones are for the greater part hard and flaggy, rarely massive, usually grey in color, sometimes sandy or magnesian, and seldom fossiliferous. In many parts of the district they are interbedded with red shales, marls, and sandstones, the former of which contain occasionally layers of gypsum, together with traces of rock-salt. It may be that to the presence of these saliferous marls, and their denudation along the Ord and Negri, the brackish character of the water near the junction is due.

125. Over a great part of this country the limestone crops out in bare masses, cut through by numerous gullies and watercourses, along which the rock often forms high cliffs and scaurs showing the stratification (which dips at a very low angle, in various directions) very distinctly. In some places the travelling on horseback over this country is very rough and difficult, but it cannot compare in this respect with Rough Range, hitherto described, which is quite impassable for horses. In the latter case, the rocks dip at a rather high angle, and therefore afford greater facilities for their denudation into peaks, pinnacles, and ledges; while in the Ord limestone district, the strata lying nearly horizontally, no such facilities are given: denudation takes place along the joints, and, consequently, terraces—not very difficult to surmount—not peaks—are formed. In travelling at night, however, one has to be careful to avoid certain deep well-like cavities with which this limestone abounds. The limestone here must be at least 600 feet thick.

126. Although on the whole not very fossiliferous, in fact rarely so, in places quantities of fossils may be seen, but these are usually so worn by the excessive action of weathering in this tropical climate that identification as to species is almost impossible in many cases. Still it is possible to recognise such forms as:—a coral resembling *Syringopora*; and many *Brachiopods*; among others, specimens of *Athyris*, *Atrypa*, *Spirifera*, *Rhynchonella*, and *Terebratula*, &c.

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* Notes on a Collection of Fossils and Rock Specimens from West Australia, North of the Gascoyne River. By W. H. Huddleston, M.A., F.G.S., Quart. Journ. Geo. Soc., Nov. 1883, p. 582. *See* also Geological Report on the Kimberley District, E. T. Hardman, 1884, p. 20.

† *See* Wallace's "Australasia," p. 66. E. Stanford, London.

127. *Flint, Jasper, Agate, Calcedony, &c., in the Carboniferous rocks.*—During the exploration of 1883, I was much astonished at the vast quantities of the above minerals which were to be found in the gravels of the Lennard, Fitzroy, Margaret, and other rivers. I have succeeded this year in tracing them to their source, and find that they are the result of Pseudo-morphic action on the limestones of different formations. They occur in the tertiary limestone rocks of the Mt. Elder Range, in the Carboniferous limestones, and in the Devonian limestones.

128. In the Carboniferous formation they are best seen at Agate hill (J 38), where they extend some miles, and form a mass of almost pure white calcedony from 100 to 150 feet in thickness.

129. Following the limestone rock upwards, it is seen to pass gradually into a highly siliceous limestone, and becoming more and more siliceous it finally becomes a flinty rock, passing by insensible gradations into white calcedony, with bands and nodules of agate.

130. The limestone here is not very fossiliferous, but a few Carboniferous forms were observed, and some of these may be traced in the calcedony and flint, although almost obliterated by the change the rock has undergone. However, the transition of the limestone to agate is so very plain that this evidence as to its age is superfluous.

131. It has a strange appearance this great hill, 2 or 3 miles in diameter, of pure white siliceous rock. On the limestones at the base are hugh masses of calcedony, often 10 or 15 feet high and 10 feet in diameter, which have fallen down from the cliffs above.

132. The formation exhibits the stratification of the original rock (*See* Section 5.)

133. At Mt. Deception, a few miles below the Junction of the Ord and Negri, there are some remarkable deposits of Jasper, which rest directly on the basalt. Some of the Jasper is of a deep blood red color, streaked with green, while other specimens are laminated; the laminæ being colored in various tints of red, grey, green, white, black, &c., and often highly ornamental. This rock occurs in scattered masses, extending for a few miles in this locality, and occasionally forms hills and ridges about 100 feet in height, as for instance near the bank of the Ord, opposite J 41; and in the distant hills small patches of it are seen resting on the basalt. (*See* Plate 10).

134. It is impossible to tabulate the exact age of these Jaspers, seeing that not the slightest trace of a fossil has been discovered in them. But I consider it most likely that they are of the same age as the limestone which occurs close by at the mouth of the Negri, and that, like the agates, &c., of J 38, they have been formed by the alteration of the limestone rocks by pseudo-morphic action.

135. Where water, holding small quantities of carbonic acid and silica in solution, comes in contact with limestone, the result is that small portions of carbonate of lime are dissolved and carried away. As water can hold in solution but a limited quantity of mineral substances; by a well-known chemical law the more soluble (namely, carbonate of lime) is retained, while the less soluble is deposited. And as this solution and deposition goes on *pari passu*, it follows that the particles of silica deposited assume the form of those of lime abstracted, so that in the course of time the entire rock, whilst still retaining its original form, is completely altered in substance. This phenomenon is known as Pseudo-morphism.

136. It has now been known for some years that flinty beds in some of the older rocks in Great Britain and Ireland have been produced in this way.* And if we consider how much greater facilities there must be for such chemical action in hot countries, such as that now being described, we cannot wonder that the effect should be so marked. It must be remembered that warm water is capable of holding considerably more mineral matter in solution than cold. The rocks and soils have become intensely heated during the wet season, and water lying on them becomes so warm that I have been assured by men who have had to wade through flooded country at such times that they could not endure it. This intensely heated water would therefore dissolve and hold in solution a much larger percentage of silica than water in a more temperate climate, and cooling as it found its way through the rocks would deposit the excess in the place of the more easily soluble carbonate of lime.

137. *Trap Rocks, Basalt, &c.*, of Devonian age. These rocks should be fitly described here, seeing that they underlie the above and rest on the next to be noticed, namely, the Devonian.

138. They consist of many varieties of basalt, including dolerite and anamesite, trachy-dolerites, lavas, volcanic breccias and ash beds, Ferruginous Wackenite, &c.; and, as already mentioned, occupy a very extensive area of the country to the east of the Ord.

139. The basaltic rocks not only occupy a considerable superficial area, but they are also of considerable thickness; at J 32 the height of the basalt above the Devonian rocks is close to 600 feet, and as it dips inwards at an angle of 10°, must be about 900 feet thick, while at J 42, near Mt. Close, the basalt is 1,126 feet higher than it is on the Ord River, and in all probability is not far short of that measurement in thickness, if not indeed greater.

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* *See* "Life History of the Earth," Prof. J. Alleyn Nicholson.

Also, "On the Chert of the Carboniferous Limestone of Ireland," Prof. E. Hull, F.R.S.; and E. T. Hardman, Trans. Roy. Dub. Soc., 1878, Proceed. Roy. Soc., London, 1877.

140. This formation occurs as a vast sheet or flow of volcanic rocks, which was formerly ejected and spread out over the Devonian rocks, and subsequently in part denuded, then covered by the carboniferous deposits, and these in their turn being to a great extent carried away, the basalt has again been exposed over the extensive area where we now find it. That it is of an intermediate age between the carboniferous and the supposed Devonian rocks is certain, for within a short distance it is found resting on the one, and covered by the rocks of the other formation, as at the junction (and a few miles below it) of the Panton and Elvire. At J 38 the limestone is also seen resting on the trap rock. *See* Plate 2.

141. Trap rocks of the Devonian and Carboniferous period are not unknown, and in Scotland and Ireland, Cornwall and Devon, occupy some important place amongst those formations, but are trifling when compared to this vast extent of volcanic rock. So far as I know, no similar outflow has yet been discovered in Australia.

142. On the Ord district these rocks form a great plateau, as hereinbefore described. As a rule they show a distinct bedding, the lines of which dip inwards to the mountains at angles of from 5° to 10°.

143. The traps are extremely varied in character; although they may be regarded as the same rock as a whole, still in the same neighborhood many varieties of specimens can be obtained.

144. The lower portions of the ranges are generally composed of compact basalt, passing into porphyrite dolerite. These soon become inter-bedded with a very fine-grained cellular trachy-dolerite, sometimes approaching lava in appearance. The cavities in this, which are often very large, are filled with, or coated with, quartz, calcedony, and globular agates, which are often thinly coated with a green silicate of iron. Where these globules are small and numerous, as is most often the case, the light purple grey rock studded with green presents a remarkable appearance. In these rocks quartz is most abundant, and appears in some cases to be an original constituent of them, but is chiefly of subsequent deposition by aqueous infiltration. Cavities were often noted more than a foot in diameter, beautifully coated with large crystals of quartz, sometimes perfectly clear, at others enclosing crystals of magnetic iron ore, rutile, and other minerals. In the basaltic country, between J 34 and the Elvire, the ground is literally covered with large pieces of variously colored quartz, together with calcedony and agates, sometimes of remarkably handsome hues.

145. Other minerals found in this basalt are chrysolite (olivine), chrysoberyl, epidote, hornblende, and mica, and marcasite or white iron pyrites.

146. Zeolites have in no case been observed, and this fact alone would seem to show that the basalts of Kimberley are of very ancient date, as they are almost always present in the more recent basalt, but rarely noticed in those of remote age.

147. In many instances the augite, which is an essential ingredient of true basalt, gives place to hornblende, and the rock might be regarded as a greenstone or diorite. It is seen, however, to pass into the ordinary basaltic rock.

148. These rocks have often a distinctly trachytic appearance. They are then fine grained in character, micro-crystalline, but of a rough trachytic-like texture, and purple grey in color. Occasionally, fine quartz crystals may be observed. apparently an original constituent of the rock, not a subsequent one. They resemble the trachy-dolerites of Abich, and, as this is a convenient distinctive name, I shall retain it until able to ascertain the exact composition of the rock by microscopic analysis, on my return to England.

149. Ancient lavas and breccias are common amongst these rocks, and some of the latter would seem to have been deposited under water, as they are distinctly stratified.

150. Volcanic Ash or tufas consisting of fragments of basalt, trachy-dolerite, lavas, &c., are met with also. In one locality, near Mt. Napier, the deposit contained large angular fragments of the easily recognisable Devonian grits; the nearest place where such rocks are at present found being 40 miles distant.

151. These fragmental deposits were, however, probably found not far from some ancient volcanic vent. No indications of such volcanoes were actually observed. But there are many high peaks and cones visible across the plateau, some of which may prove, on more careful examination than we were able to give, to be portions at least of the ancient craters. At the same time, the country has been subjected to such a vast amount of denudation that it is only barely possible that any of them should retain their original form.

152. *Ferruginous Wackenite*, or "Wackenitic dolerite," is a rock which caps the summit of Mt. Napier. It is a deep red in color and somewhat columnar in structure. When broken into it appears like a mass of somewhat pebbly red hematite, but it is simply the result of the gradual decomposition of the basalt which forms this hill. This wackenite cap is 20 or 25 feet thick. *See* Plate 4.

153. While writing of this basaltic outflow, it may be well here to describe other basaltic rocks which occur in the district, because although there is no precise evidence to entitle us to say distinctly that they are of the same age, there are strong reasons to lead us to suppose that they belong to the same period.

154. Along the western and southern extremity of the Leopold Ranges a band of trap rock, about a quarter to half-a-mile in width, occurs. It has been traced from Mt. Phillip to Mt. Huxley, and is again seen in a deep gorge, which apparently cuts right through these hills, passing a quarter of a mile north of Mt. Huxley, and continuing in a E.S.E. direction for about 4 miles. This chasm, which was named Straith-na-diaoul, is cut through quartzites and altered grits to the underlying trap rocks, which are about 500 yards wide; and these, as well as the band outside the range, have evidently been forced up long after the stratified rocks were deposited, as may be inferred from the manner in which those stratified rocks have been contorted and tossed about in the immediate vicinity of the traps. Here the traps pass from diorites into dolerites, and *vice versâ*.

155. Similar rocks are seen at the upper end of the gorge through which the Margaret passes, at J 11, where these basaltic rocks are seen in the river bed, and in the precipitous river walls for more than $1\frac{1}{2}$ miles, and, in places, for more than a quarter of a mile in width. That this basaltic outburst is of later date than that of the overlying rocks is certain, as the latter, which belong to the metamorphic or Lower Silurian system, are upheaved by it to a considerable height, and greatly contorted in places. *See* Plate 17.

156. The character of the basalt here is similar in every respect to that near Mt. Huxley, and also to that of the flow basalts of the Antrim Plateau. It is highly crystalline in places, and contains large quantities of olivine and epidote, together with quartz veins. At this place a band of statitic schist has been altered, by contact, into a rock which it is difficult to determine from the trap rock itself.

157. Trachy-dolerite occurs amongst the Devonian rocks at Mt. George, and is probably of the same age as assigned to the preceding.

158. South of Mt. Angelo, and near the Mary River, there is a large mass of Dolerite, which is interesting from the amount of Magnetite it contains. It forms a series of low hills about four miles long and two wide, and Mr. Johnston found it quite impossible to take magnetic bearings from them, as the needle in some instances was reversed. I made a few experiments here, and found that the general effect of this hill on the needle was to produce a variation of 25° 30′ to E. Not only is the basalt impregnated with small crystals of Magnetite, but it contains large strings of that mineral, and pieces of loadstone showing strong polarity may be picked up in abundance; even specimens of the rock itself are found to be strongly polar.

159. In some places this rock is of a light grey color, and appears to be chiefly felspathic, the Magnetite seeming to take the place of augite, but it is seen to pass into a true doleritic rock. Asbestos and tremolite are very abundant in thin and very regular veins. These minerals are of very common occurrence in magnetic rocks, and especially in rocks containing hornblende and augite, to which minerals they are closely allied.

160. As to the age of this basalt it can only be asserted, positively, that it is more recent than the metamorphic rocks through which it protrudes; but it is most probable that it belongs to the same period as those previously described.

161. Dykes, and small irregular outflows of basalt and diorite are met with amongst the Silurian rocks, but of what age they are it is impossible to say. A rather conspicuous exposure of this kind occurs some miles South of "Laugher's Camp" (*See* Map), where it extends for some miles East and West, and is more than a mile wide, appearing in scattered rounded masses.

162. *Devonian Rocks.*—South of the Mueller Ranges are first seen a series of rocks which bear no resemblance to the true Metamorphic series on the one hand, nor to the Carboniferous on the other. They consist of beds of grey, red, and greenish hard grits and conglomerates, hard limestones often highly indurated and apparently having been subjected to the influence of heat or metamorphic action, and beds of shale often of a slaty character; they differ from the Metamorphic rocks (on which by the way they rest unconformably) in not exhibiting any true schistose structure; in a marked absence of minerals, or quartz reefs in which the former abound, and in their comparatively low angle of dip. [These distinctions are unnecessary of course where a juncture can be observed, when there can be no doubt that they are newer rocks; but, as this cannot always be obtained, it is as well to point out their distinctive differences]. On the other hand they differ from the Carboniferous rocks in their texture and hardness, which appears to be due to a semi-metamorphosis from the action of heat, a fact very noticeable in the grits and sandstones, but far more so in the limestones, which are extremely hard and slaty in texture, and devoid of fossils so far as has been ascertained at present. Microscopic investigation may, however, result in the discovery of minute forms, which will be sufficient to clearly identify the place of this formation.

163. There can be very little doubt that they are of Devonian Age, seeing that they rest unconformably on the Lower Silurian schists and slates, and are in part covered by the basaltic rocks above described, which are in turn covered by Carboniferous limestone. *See* Sections 2, 3, 4 and 5.

164. These rocks are widely spread over the district occupying the country from Mt. George to Mt. Ramsay, and for a distance of perhaps 15 or 20 miles to the North of these points, and extend southward for some miles south of J 18. Their probable extension to the North-east, laid down on the map from

notes by previous explorers, continues many miles. On the whole their extent to the immediate South of the Mueller Ranges cannot be less than 1,500 or perhaps 2,000 square miles.

165. Passing to the eastwards across a wide strip of ground composed of granitic and metamorphic rocks, we find the Devonian rocks reappearing in the Albert-Edward Range, in which they are seen to extend for about 120 miles, though as they are almost immediately overlain by the basaltic rocks their width is at no place very great, ranging from 1 to 10 miles. However, as here they dip at very high angles their general character is more clearly revealed in this small strip of country than in the wide extent to the westwards, where, owing to the low angle of dip and the gently rolling character of the strata, a few of the beds only are visible. In the Albert-Edward Range the Devonian Rocks are seen to be composed of several alternations of grits and sandstones, limestones, and shales, all more or less indurated or partially metamorphosed. At the Crater Camp, in the distance of three-quarters of a mile, there are two distinct alternations of grits and limestones, &c., while further North, near Mt. Kinahan, there are three. *See* Sections 2 and 3.

166. If the maximum thickness of the Devonian beds be calculated from the angle of dip, taking an average of 20°, their thickness must be at least 10,944 feet, rivalling the Old Red Sandstone rocks of Monmouth and Brecknock, which attain a thickness of 10,000, and far surpassing the Devonian rocks of Canada, the thickness of which has been estimated by Sir W. Logan to reach 7,000 feet.

167. The above calculation has been taken from measurements near Mt. Kinahan; but at the Crater Camp, some 15 miles South, the thickness of the Devonian rocks does not appear to be more than 5,000 to 6,000 feet, however. The greenish slates in this vicinity are probably 400 feet thick.

168. I have mentioned that these Devonian rocks show a considerable amount of former metamorphic action. This is especially noticeable in the slates and thin flagstones near Mt. Forster, and near Fish Pool, where the beds are highly indurated, foliated, and micacised, and curiously twisted.

169. As before remarked, no recognisable fossils have been obtained, but I should state that in one locality specimens were procured which seem to show the dilapidated remains of a plant. I hope to be able to submit this specimen shortly to Baron Von Mueller.

170. *Chert, Flint, Agate, Calcedony, &c.*—The limestones of this formation exhibit the same phenomenon as do the Carboniferous rocks, viz., that the upper portions of many of the limestones are converted in part or wholly into the above minerals. Mt. Frank, South of the Lubbock Range, is a notable example; also a range of hills 10 miles to the eastward, which for 4 or 5 miles are altogether composed of these siliceous minerals. A little further on, on the South side of the Mary River, there are large masses of the same rock which show every gradation from pure agate and calcedony downwards into hard limestone, so that there can be no doubt as to their origin. Here large masses of agates are seen, which may hereafter prove of commercial value. Moss agates occur in abundance, as well as quantities of opaline quartz, sometimes approaching noble opal in lustre. I should say that good opals will be found in these beds. The natives utilise all these beds for spear heads, &c.

171. *Metamorphic Rocks, Schists, Gneiss, &c.*—These occupy a very extensive area. The ground over which they have been followed on this last trip extends from the Margaret River, near Mt. Krauss, and skirting the foot of the Leopold Ranges continues in a general easterly direction as far as Mt. George; at which point they are covered by the Devonian strata. Crossing these rocks to the eastward, we find they re-appear near the Mary River and east of Mt. Christine, extending in a wide and very persistent band, in a general N.N.E. direction, for at least 150 miles, and from 10 to 30 miles in width. This band is bounded on the west by an equally persistent band of granitic rock, and on the east by the Devonians of the Albert-Edward Range.

172. In tracing these rocks to their most northern point, as colored on the Map, I have been assisted by information given me by Mr. Turner, and have also availed myself of the description of country in Mr. O'Donnell's diary, already mentioned, whom I have found to be generally correct in his notices of the rocks wherever I have followed his track.

173. This division of the Metamorphic rocks comprises a very great variety of members, as will be seen on consulting the tabular view given above. Gneiss of various colors and textures, sometimes most markedly foliated, and again approaching granite in appearance, is very abundant; while the schistose group includes almost every modification, from clay slate up to mica-schist, which often becomes distinctly gneissose in appearance.

174. As a rule the gneiss of this country is grey or black; the red variety, or gneissite, being rarely found. It may be interesting to mining readers to mention the fact that amongst the rocks of the Erzgebirge mountains, Saxony, it was found that the grey gneiss was more favorable for the yield of rich veins than the gneissite or red gneiss. *

175. Granite-gneiss is not uncommon amongst these rocks, that is, a fine grained and only slightly foliated gneiss. It occurs frequently on the Margaret River above the Leopold Ranges. A coarser

* Scheerer, über die Gneusse des Erzebirges, Zeit schift der deutschen Geol. Ges., Vol. XIV.

variety is seen on the same river below the ranges, where the dark grey, or almost black gneiss is seen to pass distinctly into granite of the same color.

176. These granites occupy a large patch of ground in the neighborhood of the Margaret River about 10 miles west of the Leopold Ranges, and form a series of very rugged but low hills trending in a direction about N.N.W. Similar granites in places, distinctly foliated, are found in the vicinity of Rock-hole camp to the West of Mt. Dockrell. As far as I have been able to judge from the rapid examination I was obliged to make of this district, it appears that the grey granites are as a rule metamorphic, while the pink varieties are for the most part intrusive. There are a few exceptions, however, in the latter case (*See* Report 1884, p. 10.)

177. Porphyritic Diorite was noticed in several places on the Margaret and Elvire Rivers; it often has a slaty structure, and appears to pass by transition into the schistose rocks. The crystals of felspar or hornblende are often somewhat large.

178. *Quartz veins.*—In all the rocks above referred to, quartz reefs and veins are very numerous, but most especially so in the gneissose and schistose rocks. In the granites below the Leopold Ranges they are not very abundant, although often noticeable. Here they strike usually East and West, or a little to the North of West; but in all the metamorphic rocks to the eastward they are found plentifully. In many places these quartz veins look to be promising for metals, and often contain quantities of black iron sand, iron pyrites, &c. They vary in thickness from 1 to 8 feet.

179. The schistose country, stretching from the McClintock Ranges to the N.N.E., is traversed by an enormous number of quartz reefs. In some localities many of these occur in the space of a few hundred yards, and it was quite usual to notice 25 or 30 large reefs while riding over a mile of ground, without taking into consideration the smaller reefs, veins, or strings. The quartz constituting these reefs is of a very favorable character. It is a dull yellowish and grey quartz, very cellular and vuggy, containing quantities of black and other oxides of iron, together with casts of, and often crystals of, iron pyrites. From most of the surface quartz the enclosed minerals have been washed away however, although their traces are still apparent. Minute specks of gold have been noticed in a few cases, and I have very little doubt that many of these reefs, when properly examined and tested, will prove to be auriferous.

180. The quartz reefs in this part of the country have a bearing of N. 10 W. to N.E.; many run due N. & S.; some of them can be traced for many miles.

181. It is most probable that these quartziferous rocks are a spur or continuation of the gold-bearing Metamorphic rocks of the Northern Territory, S.A.

182. *Quartzites and altered grits*: These, which belong to the Metamorphic series, form several high mountain ranges and hills in Kimberley. They appear to be principally developed in the Leopold and Mueller Ranges, the former of which have been previously described,* and the latter, which are only a portion of this general plateau, being formed of the same rocks. It was only possible to penetrate into these ranges for a few miles, and for this distance only quartzites with altered grits and conglomerates were the predominant rocks; sometimes micaceous and chloritic schists and purple slates were observed, but not frequently. It is not unlikely, however, that when these ranges are at some future time explored, they will be ascertained to be largely composed of the other varieties of Metamorphic rocks, such as schist, gneiss, &c. For the present, it only remains to indicate roughly their general character, so far as it is known.

183. It would appear from the sections which have been examined, that these quartzites are the oldest rocks in the district: thus, at the gorge near J 11, they are found to dip beneath the chloritic and hornblendic schists and gneissose rocks; and the same occurrence is shown all along the base of the Leopold Ranges wherever I had an opportunity of observing them. They appear to roll over to the N.E. and again to dip beneath the schistose rocks of the Lower Margaret River.†

184. As a rule they dip at very high angles, rarely less than 45°, and sometimes as high as 60°; but they are often observed to have a very persistent dip of not more than 15° or 20° at most. At the southern edge of the Leopold Ranges, near Mt. Huxley, they are seen to be highly contorted, and in one place exhibited a very fine section of plications, resembling those near the Old Head of Kinsale, County Cork, Ireland. It cannot but appear remarkable to those not accustomed to investigate such phenomena that these intensely hard rocks should have been thrown, as it would seem, with the greatest ease, into these convolutions, in some cases of a very complex form. I regret that, owing to the number of illustrations designed to show the general feature of the country which accompany this report, I am unable to find space for detailed sketches showing such interesting rock characteristics, but I hope to publish some of them at a future time.

185. Owing to the highly contorted structure of these quartzites, one may walk over a tract of country nearly along the strike of the rocks, in which the beds are sometimes horizontal, and again appear to dip at every variety of angle and direction.

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* *See* Report of 1884, *sup. cit.*

† In order to avoid confusion, I speak of that part of the Margaret River below the Leopold Ranges as the Lower Margaret.

186. The rocks composing the Leopold and Mueller Ranges are of various textures. They are sometimes pure crystalline quartzites, and sometimes fine grained, but highly indurated grits, having an almost vitrified appearance. Coarse pea-grits, and quartzose conglomerates, are everywhere met with, and as a rule the whole mass shows indication of extreme metamorphic action. Interbedded with these, however, we meet with beds of soft sandstones and purple slates, which have apparently suffered no alteration whatever. The same phenomena was noticed in the Usborne District in 1883 (*Vide* Report *sup. cit.*)

187. This section of the Metamorphic rocks extends along the Mueller Ranges for at least 60 miles.

188. The same rocks appear again in Mt. Barrett and the hills to the South-west of it, for 15 miles. *See* Plate 9.

189. In the schists and gneissose rocks of the Elvire River to the eastwards of Mt. Barrett, low quartzite hills are not infrequent, forming parts of ridges of this material, which usually strike about N.E. Still further East, at J 25 and J 26, the schists are interstratified with thick beds of flagstones, grits, and coarse conglomerates, all more or less indurated by metamorphic action. These are as far as possible indicated on the map. Like the accompanying slates and schists, they are quartz-bearing, and in one locality the quartz showed traces of gold.

190. Quartz rock occurs in a series of peaks, trending East and West nearly, a few miles South of Mt. Huxley, for about 7 miles; the most prominent of these we have named Mt. Fairbairn and Mt. Onslow.

191. *Granite, Syenite, &c.*—Intrusive.—Circling the Leopold Ranges from some distance to the North of Mt. Philip is a broad band of igneous rock, chiefly granitic. The granite is of a reddish color from the presence of pink felspar, some of the crystals of which are often two inches in length. It is a Porphyritic Granite. Its other constituents are quartz—sometimes of a translucent greenish color—black, and also white mica, and occasionally a little hornblende. *Olivine* is an almost constant accessory mineral in these irruptive granites, and also in many localities *epidote*.

192. The Granite of this part of the district often takes the form of massive rounded hills, presenting all the appearance of having been formed by glacial action. To any one acquainted with the peculiar appearance of granite hills in northern latitudes which have been obviously shaped in great part by the planing power of ice, the "roche montonnée" aspect of these granites is most striking. It is due, however, to a peculiar spheroidal structure on a very large scale, the result being that the rock weathers in rounded masses showing an internal structure resembling the section of an onion. One of these rounded hillocks on the Louisa River is about a quarter of a mile in diameter and about 150 feet in height.

193. These granitic rocks are in this part of the district—that is to the South of the Leopold Ranges—extremely irregular in their distribution. They burst up through the older schists and slates in such an erratic manner that it would be utterly impossible to give anything like a correct delineation of them on a map of the scale of that subjoined; it has only been possible to mark on this the main outlines. This section of the granite formation has been traced, however, in frequent outbursts to the commencement of the Upper Margaret River, and it extends some 9 or 10 miles to the southward, not continuously but appearing at intervals amongst the metamorphic rocks as far as the gravel hills South of the Louisa.

194. *Syenites of the Louisa River.*—In this same district there are large intrusions of syenite. The rock here is a dark grey compound of quartz, felspar, and hornblende, with a little black mica. It crops out freely, close to the Leopold Range, near Mt. Huxley, and for a couple of miles to the south, towards Mt. Fairbairn. A little to the north-west of this hill its junction with the granite is well defined, and it is clear that they are altogether distinct rocks, as they penetrate each other in wedge-shaped and perfectly distinguishable masses, the granite here being red, the syenite black. It is impossible, however, to say at present which is the older rock, although it may be inferred that the syenitic rock is; for it has been remarked that when syenites and granites occur together, the granites, being the richer in silica, are almost invariably the most recent.*

195. These syenites are usually fine grained, and contain a very large proportion of hornblende. To the eastward, about 8 or 10 miles from Mt. Huxley, we meet with a very coarse porphyritic syenite, with large crystals of greenish quartz and pink felspar, hornblende, and a little mica. This covers the ground for some miles in huge masses, crags, and boulders.

196. *Granites and Syenites of the Upper Margaret, &c.*—From the western side of the McClintock Ranges a band of these rocks continues in a N.N.E. direction for more than 120 miles, and having a width of 10 to 20 miles. They form a very well marked ridge, which is easily recognisable, owing to the peculiarly rough character of the ground, from some distance, although in no place does it rise to any considerable height above the surrounding country; the main watershed, although 1,400 feet above the sea, not being more than perhaps 150 feet above the general level.

197. Here the granites are mainly composed of pink felspar, white and black mica, and quartz, often of a greenish color. They are usually of a coarse texture, but rarely, if at all, porphyritic. In many cases

* B. von Cotta, Rocks classified and described, p. 187.

however, the granites in this part of Kimberley are seen to be grey and fine grained, and to a certain extent showing traces of foliation. No doubt these grey granites are metamorphic, but it was impossible to draw any definite line of demarkation between them and the red variety. There is every reason to think, however, that they pass gradually into gneissose rock.

198. On the other hand, the red granite appears to be invariably intrusive, as it has been observed in many places protruding through the schistose slates and other Metamorphic rocks.

199. To the South-west of Ramsay Range, the granites form a series of low rugged ranges forming a spur extending westwards from the main ridge. Near the junction of the Mary and Laura the character of the country becomes very peculiar. From this point eastward to the South of Mt. Christine the country is one mass of granite, the solid rock being covered by immense boulders and huge angular blocks of the granite itself. As far as one can see in any direction, low granite hills capped with these immense fragments, often 10 feet in height, or valleys profusely covered with the same material, are seen. Some of these great blocks rest on pillars, and are not unlike *cromlechs*, while in other places on the bare rock are fragments—many feet in diameter—laid on each other in such a manner as to suggest an artificially constructed wall; or on the top of some high flat rock might be found resting almost perfectly rounded boulders, seemingly without difficulty movable.

200. Near the place where we crossed the watershed on this granite ridge, at the point marked 1,400 on the map, we noticed, amongst the many curious and fantastic forms the granite had assumed, one exactly resembling a very common form of *cromlech*, consisting of a huge capstone perched on several rough granite blocks, the whole structure being about 24 feet in height; the capstone, which was rudely circular, was about 30 feet in diameter, and 10 to 18 inches thick. We calculated that the weight of this megalith must be at least 500 tons. It reminded me strongly of the celebrated Laec-an-Scail, near Waterford.

201. Phenomena like this can only be accounted for by the great force of atmospheric denudation in these tropical climates, combined with a want of homogeneity in the structure of the rock itself. The softer and looser parts would be more quickly eaten away; and we must not only consider the effect of rain, but at the same time that of wind, which in times of storm would force rain and sand into and against crevices previously formed by unequal expansion, due to great changes of temperature: the edges would become gradually but surely worn off, and according to the direction and nature of the jointing there would result pillar-like masses, tabular forms, or rounded boulders.

202. This granitic ridge has been ascertained to extend to east and north-east of Mt. Barrett, along a portion and to the north of the Panton river, and for some 40 miles at least to the N.N.E. of the north-westerly branch of the Ord River, as indicated on the map.

203. *Syenites, &c., of the Mary River.*—North of Rock Hole Camp, extending to Syenite Camp on the Mary River and for some five miles to north of the latter, there are great rough masses of rock freely exposed, in appearance very similar to those in the adjoining granitic country. On examination, however, they proved to consist of several varieties of Syenite passing from Syenitic-Granite—which is possibly a modification of the red granite of the district—into true Syenite, and from that into Syenite Porphyry, and a rock which containing but little quartz answers to the description of Syenite as understood by the German petrologists. I use the term Syenite here, however, according to the English acceptation of the term, meaning, that is:—a rock containing as essential minerals quartz, felspar, and hornblende, with little if any mica: a rock which Roziere has proposed to call Sinaite.

204. Syenitic-Granite occurs chiefly near the edge of the granitic country, and is a rather fine grained red granitic-looking rock, from which it only differs in respect of its containing a considerable quantity of hornblende.

205. It passes by insensible gradations into a rock in which mica is almost totally absent and is replaced by hornblende. White felspar is also an accessory ingredient, and the rock is of a greyish to a greenish color.

206. This again passes into Syenite Porphyry, and at "Syenite Camp" this forms a very handsome and highly ornamental rock, exhibiting a greenish ground or matrix formed by a mixture of felspar and hornblende, in which are imbedded large crystals of bright pink and white orthoclase felspar, sometimes more than half an inch long, together with crystals of hornblende, and a little mica. Quartz is also abundant.

207. This rock occurs in great rounded and angular masses for some miles along the Mary River, and on the country on each side.

208. In some places the quartz diminishes, or even disappears altogether, and the rock exhibits the appearance of a diorite or diorite-porphyry. However, as the felspar is not a basic one, but orthoclase, the rock cannot be classed with that division. In fact the absence of quartz is merely a local distinction, the general character of the rock being tolerably constant.

209. Again we find this curious rock passing into a fine grained almost serpentinous looking compound, streaked or mottled red and green and presenting to the naked eye no marked crystalline character. It is, however, certain that it forms a part of the mass of these syenitic outbursts. Hand

specimens taken from these rocks would convey the idea that they belonged to very different formations, whereas investigation on the spot proves that they belong to one great whole.

210. *Olivine* is a frequent constituent of these syenites, and *epidote* occurs very abundantly in veins sometimes more than an inch in thickness.

211. Another locality where syenite was observed is in the country a little to the S.W. of Ramsay Range, where a small strip of granitic country is marked on the map. Here granites, syenites, and diorites are in a very small space mixed up in a most confused manner, insomuch that it would require a map on a very large scale to allow of their being even partially indicated. Epidote is here very abundant both amongst the red granite and the syenite. Thin veins of basalt frequently penetrate these rocks.

212. In the granitic rocks there are numbers of quartz veins, reefs, and "blows," and some of these attain a considerable thickness. 7 miles South of Mt. Barrett is a small hill through which a quartz reef, 60 feet wide, runs in a direction E.S.E. and W.N.W. for about half a mile, throwing off one or two spurs about 10 feet in width; and a similar quartz blow was noticed to the N.N.E. of Syenite Camp, where the quartz hill forms a remarkable feature in the landscape. It is 100 feet wide and extends N.E. for about one-eighth of a mile, when it seems to disappear. These consist of white, rather glassy, and sometimes brownish quartz, very cellular in parts, and containing sometimes a little iron-sand.

213. Many of the quartz reefs in the granites and syenites are persistent and regular. In the district about Syenite Camp just mentioned, there are many of these often several feet in width, and traceable for more than two miles. Their general bearing seems to be northerly, varying sometimes from N.N.E. to N.N.W. and are occasionally crossed by veins, running nearly E. and W. In this district the quartz contains quantities of black and brown oxides of iron, and iron pyrites, and may prove, hereafter, to contain more precious metals. In many places along our track, here, the ground is white for miles on account of the fragments of quartz scattered over it.

214. It would be, however, impossible to particularise instances where quartz-veins of good-looking appearance are found on these rocks, as they are everywhere abundant.

215. In the granites of the Lower Margaret, between the Leopold Ranges and the Gravel Hills on the Louisa River, many quartz reefs are seen, chiefly bearing East and West; in a few instances these appear to be likely to be metalliferous.

216. *Diorite* is met with frequently throughout the district, both in dykes and masses. It often appears to pass into a basaltic rock in which the hornblende is replaced by augite; this is especially noticeable in the rocks nearer the Leopold Ranges which have been buried under a great depth of superincumbent rocks, when it is difficult to distinguish the true greenstones from the basalts, and *vice versâ*. Several large dykes of diorites are met with on the Mary River.

217. *Gabbro*, *Diallage Rock*, and *Hypersthenic Rock* are found in large masses on the Upper Margaret about 2 miles below the opening of the gorge, and again, below the gorge on the Lower Margaret.

218. *Basalt.*—The chief mass of this has been already described, under the head of Devonian Rocks. Many smaller masses and dykes occur in the district, the age of which is uncertain, as for instance near J 18, where a lenticular patch of amygdaloidal basalt, 4 or 5 miles long and 1 mile wide, has burst up through the Devonian rocks.

219. On the Elvire River the metamorphic rocks are seen to be penetrated in many places by dykes and masses of basaltic rock, also of uncertain age save that they must be newer than the rocks which they have cut through. The slates in immediate contact with these dykes are altered to hard flinty masses, exhibiting a curiously curved foliated structure. Another curious circumstance is, that some of these basaltic masses are cut through by quartz veins of a similar character to those in the slates close by.

220. To the south of the Leopold Ranges, between Mt. Huxley and J 10, is a large mass of basaltic rock extending for several miles in every direction. It shows at the surface in very rough masses which have a distinctly columnar structure, and is more fine grained, and somewhat different in appearance to that previously described. I have very little doubt, however, that it belongs to the same age as that at the Margaret gorge, and, probably, as that of the Antrim Plateau. It bursts through the quartzites on the flanks of the Leopold Ranges, which rocks are forced into vertical walls with which the basalt is, as it were, dovetailed in a series of interlacing joints.

II.—LIST OF FOSSILS COLLECTED IN THE KIMBERLEY DISTRICT.

	Upper Tertiary.	
Gasteropoda ...	Planorbis Hardmani ...	At J 40.
	Carboniferous Sandstone.	
	Annuloida.	
Echinodermata ...	Pentremites, sp.	Lake Joceline.
	Poteriocrinus crassus ...	do.
	Actinocrinus, sp.	do.
	Platycrinus, sp.	do.

Mollusca.

Polyzoa ...	Ceriopora, sp.	Lake Joceline.
Brachiopoda ...	Producta gigantea	Fitzroy River near Mt. Abbott and Lake Joceline.
	„ longispina	
	„ semi-reticulata ...	
	„ sp.	
	Orthis resupinata	Fitzroy River, E.S.E. of Mt. Abbott.
	„ species	
	Spirifera striata	Same locality, also Lake Joceline, and in broken fragments S. of the Grant Range.
	„ sp. casts of	
	Streptorhynchus crenistria (frequent)	Same localities.
	Chonetes Hardrensis	Fitzroy and Lake Joceline.
Lamellibranchiata	Curtonotus elegans	Liverynga.
	Pecten, sp. (very plentiful) ...	do.
	Mytilus, sp.	do.
Gasteropoda ...	Natica, sp.	do.
	Loxonema, small sp.	Lake Joceline.
Heteropoda ...	Bellerophon Urii	Liverynga.
	„ sp.	do.
Cephalapoda ...	Goniatites (small broken), species undeterminable	do.
	Orthoceras (fragments), undeterminable	Lake Joceline.

CARBONIFEROUS LIMESTONE.

Protozoa.

Spongida ...	Stromatopora concentrica? ...	Mt. Krauss and neighborhood.
	„ placenta ...	

Cœlenterata.

Actinozoa (*Tabulata*)	Chætetes tumidus	Rough Range and Mt. Krauss.
	Stenopora tasmaniensis? ...	do.
Do. (*Rugosa*)	Cyathophillum, sp.	do.
	Lithodendron affine	do.
	Lithostrotion, sp.	do.
	Syringopora, sp.	do.
	Zaphrentis, sp. (small) ...	do.

Annuloida.

Echinodermata ...	Actinocrinus, sp.	Common throughout the limestone.
	Platycrinus „	
	Poteriocrinus crassus ...	

Annulosa.

Annelida ...	Spirorbis, sp.	Abundant on Corals of Mt. Krauss.
	Serpula, „	

Mollusca.

Polyzoa	Fenestella plebeia?	Hills near Mt. Krauss.
Brachiopoda ...	Athyris ambigua	Mt. Panton.
	Crania, sp.	Rough Range.
	Discina, „	do.
	Orthis resupinata	Rough Range and Mt. Pierre.
Brachiopoda ...	Producta gigantea	Near Mt. Krauss.
	„ semi-reticulata ...	Various localities.
	Rhynchonella pleurodon ...	Rough Range, Mt. Pierre, &c.
	„ cuboides ...	
	„ pugnus ...	Do., also at Mt. Panton.
	Spirifera striata	Near Mt. Krauss.
	„ sp.	do.
	„ Hinge joints only ..	Mt. Panton.
	Streptorhynchus crenistria ...	Mt. Pierre, &c.
	Terebratula hastata? much worn	Mt. Panton.
	„ sacculus? ...	Mt. Pierre.
Lamellibranchiata	Curtonotus elegans	do.
	Aviculopecten granosus? ...	Rough Range.
	Pleurorhynchus, sp.	Mt. Krauss.
Gasteropoda ...	Pleurotomaria, sp., much worn	do.
Heteropoda ...	Bellerophon, sp.	do.

Pisces.

	Small palatal tooth	Ord River.

221. The fossil sponges or *Stromatopora* are very abundant in the limestone rocks opposite Mt. Krauss, and are sometimes very large, some specimens having a diameter of more than 18 inches.

III.—DETAILED DESCRIPTION.

222. In the preceding pages I have been obliged to describe rather fully the character of the country passed over, and with the help of the Map, Sections, and Sketches, the reader will probably have been able to form such an idea of the district as to render further details almost unnecessary. Nevertheless, it will not be out of place to give a few descriptions of sections passed over in our journeys to hills distant from the main line of route.

223. *Mt. Campbell, Rough Range, and the Margaret River to Mt. Huxley.*—The hard grits which form Mt. Campbell disappear under low undulating and flat grounds consisting of gravels and soils, which, although of good quality, rarely bear any vegetation but spinifex and shrubby timber. 5 miles to South-east sandstones and thin flaggy limestones crop out, showing horizontal bedding, and at $8\frac{1}{2}$ miles in the same direction rough rubbly limestone appears, continuing at intervals, with intervening patches of soil and gravel, up to the limestone ranges.

224. From these ranges to the Margaret River the same character of country prevails. Flaggy limestone, with thin beds of grit intermixed with shales, appearing frequently from beneath the recent beds of gravel and alluvial soil, until the neighborhood of Mt. Pierre is reached, when the limestone rises into a ridge composed of several low hills to a height of about 100 feet above the plains. These limestones are hard and flaggy, dipping at low angles, are usually horizontal, and are very fossiliferous.

225. West of Mt. Pierre are limestone ranges, consisting of thin well-bedded grey limestone, with a few thin grit bands showing prominently in the sides of the hills, the outcrops following the contour lines. The dip is rather undulating, but the general direction is N.E., at 5° to 20°. A few encrinites and traces of mollusca were the only fossils noticed.

226. Similar limestone crops out at intervals along the banks of the Margaret River, as far as Hull Range. Here they often are massively bedded, and are very fossiliferous; *see* list.

227. From this point a long spur of limestone stretches eastwards for several miles.

228. The carboniferous limestone appears again to the southward in two small patches, amongst the Boulder Hills previously described. They no doubt underlie those recent formations, and continue to the similar rocks of Rough Range, which have been traced for nearly 40 miles in a S.E. direction.

229. *Carboniferous Sandstone,* conglomerates, and breccias were noticed to the South of J 9, in the Boulder Hills of the Louisa; they are generally coarse in texture and reddish in color. The breccias near J 9 are composed of large fragments of quartzite grits, and chloritic and other schists.

230. The rocks composing the hills called the Haughton Ranges are evidently sandstone, and as they are plainly seen to rest conformably on the limestone of the Rough Ranges, there can be no doubt that they belong to the same epoch. They form a series of nearly flat-topped hills, the rocks dipping gently to eastwards at about 5°.

231. *Metamorphic Rocks.*—These first make their appearance on the Margaret about 8 or 10 miles below Mt. Krauss, where about a mile South of the river roughish ground is met with, and where micaceous, andalusite, and talcose schists crop out freely, dipping nearly S.W. at 75°. The carboniferous limestone crops out close by and seems to have been brought into its present position by a fault running nearly S.E. Further East these rocks evidently pass into gneiss associated with hornblendic rock, and finally into black granite, clearly Metamorphic, large masses of which extend in low hills for some miles.

232. The schistose rocks are well developed for about 15 miles to the eastwards, and are often traversed by large quartz veins and reefs, which usually run E. and W. Past this point, viz., where our track crossed the Louisa river, they are invaded by large intrusions of granite, syenite, and trap rock, and in the neighborhood of Mt. Huxley the ramifications of the different igneous and Metamorphic rocks become so complicated that even on a map of a very large scale it would be extremely difficult to represent them correctly, even with plenty of time at one's command.

233. *Quartzites, &c.*—In the vicinity of Mt. Huxley we first met with quartzites and metamorphic grits. Those of the Leopold Ranges have already been described. In the lower ground, near the base of the mountains, ridges of quartzite, often forming high peaked hills, rise from amidst the other Metamorphic and the igneous rocks in the most bewildering and unaccountable manner. There can be no doubt that in ancient times this part of the country has been subjected to very violent volcanic disturbances, and is in many places traversed by faults of great magnitude.

234. The quartzites usually dip at a very high angle—sometimes vertically; appearing then like dykes, or walls of rock, continuing for a considerable distance in very regular lines. These are very noticeable about 14 miles E. of Mt. Huxley, where the quartzite is invaded by great masses of basalt. They strike persistently to S.E.

235. South of Mt. Huxley is a remarkable hill of pure white quartzite rock (Mt. Fairbairn), about 400 feet high. Its continuation eastward is traceable for 6 miles to Mt. Onslow.* The quartz dips to S.W. at an angle of 60° and overlies gneiss and schists, which in turn repose on granite. The general trend of the hills is about E. by S. Mt. Fairbairn is made up of two high peaked ridges, the centre having been denuded away, and it is somewhat more than ¼ mile wide.

236. *Intrusive Granites and Syenites of the Margaret and Louisa, &c.*—These have been pretty fully treated of in the General Description. From Bald Rock they skirt the base of the Leopold Ranges, showing at intervals in rough hills through the more recent gravels, &c. And south of Mt. Huxley they widen out into a great mass extending as far as the foot of the gravel hills (J 8 and J 9, &c.); then extending eastwards to within 6 miles of the Upper Margaret; where, however, small outbursts are seen at intervals.

237. These granites and syenites are, as it were, dovetailed with bands of Metamorphic rock, and it is only possible to give a diagrammatic representation of them on the map. Close to J 8 walls and dykes of fine-grained granite protrude above the coarser granites and the schistose rocks. Most of these run in an E. & W. direction. Large quartz reefs, with a similar bearing, are frequent in this locality.

238. The granite is for the most part red, owing to the presence of pink felspar, and is often porphyritic. Near Mt. Fairbairn is a mass of dark grey granite resembling the Graphic Granite of Cornwall.

239. *The Gorge of the Margaret.*—Here a very interesting section was traced for about two miles. At its commencement the bed of the river for one mile is occupied by masses of Basalt, Dolerite, and Dolerite Porphyry, upon which, in the high cliffs forming the sides of the ravine, are super-imposed thick beds of quartzite and altered grits, evidently upheaved by the protrusion of the igneous mass, and often rolling over in contorted beds (*See* Plate 17). At the entrance these beds dip S. 30 W. at 45, and are covered by steatitic schists and argillites, which are seen in the bed of the river. These schists where they have come in contact with the basalt, are altered into a hard flinty rock, with well developed crystals of hornblende. In other places they are full of curious small globules of opaline quartz.

240. This peculiar-looking rock occurs again one mile down the gorge and in precisely the same position, that is, resting on the grits and quartzites which are here dipping N.N.W. at 60°, the strike taking a great sweep round to westward. At this place the river passes through a deep and narrow gorge, the quartzite cliffs rising about 200 feet above the river bed. A short distance below this is Diallage rock, hornblendic gneiss, and syenite, and further on is hypersthenic rock apparently intermixed with grit beds. A little below this coarse basalt passing into hypersthenic rock rises into a steep bank elevating the grit and quartzites in precisely the same manner as has been noted at the upper part of the cutting. From this point the grits and quartzites continue for about half a mile, the dip gradually decreasing from 60° to 15°, but rolling in places. And about two miles down the river† they dip under red, brown, and purple slates and schists, which are in turn covered by high cliffs of rough grit.

241. Quartz reefs and irregular veins are visible in places along these cliffs. In the high cliffs at the entrance to the ravine (*see* Plate 17) is an overhanging ledge which forms a recess like a cave. On the perpendicular wall of this recess are several figures of emus and other animals, together with weapons—drawn by native artists. They are simply silhouettes in smoke relieved by a white outline, and are similar to those at Mt. Pierre described in last year's report.

242. At the spot where we camped on a small brook flowing into the Margaret, the rocks are particularly complicated, consisting of quartzites and indurated pea grits with quartz veins, chloritic schists, hornblendic rock, basalt, gneiss, and mica schists, granites, &c., all occurring within the space of a mile. Quartz reefs are numerous here, notably in the hornblendic rocks, and slight colors of gold have been found in the river gravel.

243. *Section from above locality to Mt. Bertram.*—Passing across the country to the southwards for half a mile, the hornblendic rock with quartz was seen. This was succeeded by ridges of granite and syenite rising through the soil and alluvium; and about 2 miles west schists and gneiss, with many quartz veins, appeared and continued for a distance of about 7 miles from camp, where massively bedded chloritic slates, dipping S.E. at 30° occur.

244. The character of the rock now changes altogether, and is displayed in a succession of high rounded ridges, composed of hard well bedded brownish grits and flags, with soft green and reddish slates. These show traces of Metamorphic action, but they are quite distinct from the true Metamorphic series, belonging to a more recent age, and I consider them to be of Devonian age. Hard grey flaggy limestone appears amongst them in two or three places, and all these rocks dip at high angles, and are much disturbed and contorted, the strike and dip changing frequently.

245. About 8 or 9 miles from camp limestone was again noticed. It is extremely hard and apparently metamorphosed. The strike is much twisted and the beds roll over and over, and are interbedded with

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* Named after His Honor the Chief Justice of Western Australia.

† These grits cross the river bed from side to side, and being excessively smoothed by water action, and are dipping at a high angle, rendered further travelling on horseback impossible.

thin flagstones and grits, also much contorted. A narrow valley runs through this limestone country, along which we led our horses with much difficulty.

246. The rest of the section for about 4 or 5 miles continues through highly contorted grits, flags, and slates, forming a series of high synclinals and anticlinals, striking S. 30 E., as far as, and past, Mt. Bertram, the highest point in these ranges, and which has been already described. (*See* p. 4.)

247. To the eastward of this hill is an extensive valley, striking along to the southward. This is composed of green, grey, and brown slates, with a few bands of limestone. They overlie the Mt. Bertram grits, and following them across to the eastward they are found to disappear beneath the similar grits of the Lubbock Ranges, which dip N. and N.E. at 45°. The Devonian rocks of this part of the country must be of considerable thickness.

248. *Country to wards Mt.George, &c.*—The Metamorphic rocks mentioned in the last section extend across the Margaret River to J 13 and Mt. George. They consist chiefly of mica schist and gneiss, with occasional bands of quartzite and numerous quartz veins and reefs, sometimes of large size, and generally containing metalliferous indications.* Black and red oxides of iron occur in them, and the vuggy cavities are filled with ochres. They usually bear about N.E. Large blows of quartz are not uncommon, and a very remarkable example of these is seen about 4 miles above the Leopold Gorge, close to the Margaret River, where the quartz rises apparently through the mica schists and forms an almost circular hill, at least 50 feet high and 150 feet in diameter at the base. Another smaller hill occurs about 400 yards to the S.W. They have no apparent connection with any of the numerous quartz veins in the neighborhood, and show incipient lines of stratification dipping S.E. at 10°.

249. The Metamorphic rocks dip at high angles, 60° to 80°, with a general strike to the N.E. At J 13 and Mt. George they are overlaid by the Devonian grits, which rest uncomformably on them at angles varying from 20° to 45° to eastwards (*see* Section 1.) These grits, as will be seen from the Map, are a continuation of those forming the Lubbock Ranges.

250. South-west of Mt. George and on the opposite side of the Margaret River, is a high ridge of limestone stretching from the river's bank in a S.W. direction for about $1\frac{1}{2}$ miles, and showing on the northern side a steep precipice about 150 feet high. It is seen near the river to rest uncomformably on the Metamorphic schists and gneiss, but to the S.W. it dips at an angle of 80°, and is probably affected by a large fault running N.E. It is in every respect similar to the limestone observed in the Mt. Bertram Hills, and is no doubt of the same age. It is about 100 feet thick, and is covered by hard flaggy grits and tilestones dipping under brown and green slates. On the north-eastern side of the river is a prominent hill of Devonian conglomerates and flags.

251. *Margaret River, &c., to Mt. Dockrell.*—From the point last described the formation traversed consists of variously colored slates and shales cropping out frequently at surface, and usually much disintegrated. They dip generally N. and N.E. at 20°, and continue to the southern extremity of the Lubbock Ranges, by which they are bounded to the eastwards.

252. The rocks of the Lubbock Ranges are chiefly hard red, grey, and brown grits and sandstones, with a few shale beds, and, with a few exceptions, dip at low angles (20° to 30°), but the strike is considerably twisted occasionally, as, for instance, near J 19, and in general it corresponds to the contour of the hills as shown on the map. At J 17 the rocks are remarkably evenly bedded, some of the precipices showing an appearance like that of an artificially built wall.

253. At Caché Camp, near the junction of the Margaret and Mary, the Devonian rocks consist of hard thick rough grey grits and flags, dipping N.E. at 45°. And on the South side of the river are low hills of coarse rough conglomerates and hard grits, with bands of green slate at the base, all dipping S.E. at 45°. These hills are named Mt. Tean.

254. About 15 miles south of this Camp are the hills known as J 18. The intervening country is almost entirely composed of grits, flags—with a few slate bands—and conglomerates, similar to those already described as Devonian. Some of the rocks are extremely hard and quartzose, and almost resemble quartzite in texture. At J 18 the rocks are coarse red sandstones and grits, dipping N.N.E. at 20°. The extreme top of the hills is covered with blocks and boulders of very hard quartzose grit, no doubt due, as before explained, to local denudation.

255. Five miles South of these hills are seen the Haughton Ranges, on the escarpment of which crop out well bedded, red sandstones. Near their base are seen occasional out-crops of white rock, doubtless some of the agates which are so common in these formations.

256. While on this point I should mention that in some of the slates of the Devonian rocks in this section, about 3 miles North of J 18, thin bands of a white flinty mineral were observed. They are no doubt the product of alteration of thin layers of limestone in the way already described.

257. About a mile to the North of this hill, coarse, partially decomposed basalt is seen in a ridge bearing nearly E. and W., and probably one mile wide.

* Good specimens of grey and green copper ore were noticed in one of these reefs, near J 11.

258. Patches of tertiary gravels and conglomerates, composed of quartz and ironstone, were noted here, as indicated on the Map. The ground is often thickly strewn with small pebbles of black ironstone —derived from these gravels—which frequently collect in quantities in the beds of the small streams and rillets with which the country is cut up.

259. The Devonian rocks continue to within a short distance of the meeting of the Laura and Mary Rivers. At the hills marked J 20, agates as before described are seen, and 4 miles East of these are rough grey grits and flags with shales, all slightly rolling, the prevailing dip being S.W. at 10°.

260. A considerable mass of granite is now met with, and this was traversed for about 12 miles in an E.S.E. direction, and was seen to stretch away for miles upon miles to the S.W. and N.E. The physical character of this very rough and inhospitable looking country has been already described. The granites are usually of the red variety, coarse and sometimes porphyritic, and no doubt intrusive; but in many places there are bands of grey granite, sometimes hornblendic, and slightly foliated; and these are in all probability Metamorphic.

261. In these granites are many quartz veins bearing N.E. and S.W., but as we were forced to travel along quickly in search of water, no examination of them could be made.

262. Although the general character of the country is rough and barren, many small oases of good alluvial country were crossed.

263. About $2\frac{1}{2}$ miles west of Rock Hole camp the chief granite boundary was reached, and gneiss with micaceous and other schist succeeded. In these Metamorphic rocks there are many good looking quartz reefs.

264. Rock Hole camp—so called because our supply of water was derived from a difficultly accessible pool in the rocks—lies amongst rough grey granitic rock, intermingled and apparently passing into grey gneiss. This granite is no doubt of Metamorphic origin.

265. Continuing to the eastwards, the grey granite passes into gneiss, and this again into grey granite. At about two miles from the camp, however, an unbroken succession of Metamorphic rocks, including gneiss, mica schist, chloritic and talcose slates, &c., with a band of crystalline limestone, is observed to extend for many miles.

266. From Mt. Dockrell a most extensive view can be obtained, and the country to the eastward is seen for about 25 miles—that is, to the foot of the Albert-Edward Range—to consist entirely of the Metamorphic rocks, the features of this formation being so well marked that it would be impossible to mistake it. *See* Plate 6. View from J 22.

267. The schistose rocks in this section are remarkable for the number of quartz reefs they contain. In the flat country, between Rockhole Camp and Mt. Dockrell, I passed over more than a dozen good looking reefs, and on the hill itself, in a space not exceeding $1\frac{1}{2}$ miles, I counted 25, many of which contained quantities of red and black and magnetic oxides of iron, and iron pyrites. I think it most likely that some of these reefs are gold-bearing. The above named minerals are known to be indicative of gold in rocks of this formation, and I have myself obtained excellent colors, in fact "shotty" gold in the Mary River not far off.

268. The Metamorphic rocks of Mt. Dockrell consist of chloritic schists and slates, with gneissose gritty micaceous schist, all dipping at high angles (about 75°) to W. & E. and striking about N.E.

269. The quartz veins and reefs, which are often from 6 inches to 4 feet thick, strike N. to N.N.E. crossing the strike of the rocks; they are very vuggy and cavernous and are often of a bluish-grey color. From the summit of this hill they can be seen to extend for many miles N. and S.

270. What has been said as to Mt. Dockrell and the surrounding country applies equally to the hills some 22 miles to the N.E. (J 18) forming the northern extremity of the McClintock Ranges. Tracing the rocks from the granite to the West of Laugher's Camp the same sequence of rocks and the same character is observed, the section showing gneiss, schists, and slates of various kinds, with many thick and promising looking quartz reefs. For some distance West fromt he base of J 22 there is a considerable thickness of chloritic and talcose slates, but the summit of the hill, like that of Mt. Dockrell, is chiefly composed of hard gritty micaceous schists and schistose flags with many quartz veins.

271. Ten miles North of J 22 is a high peaked spur of Metamorphic rocks trending nearly E. and W. The character of the rocks is similar to that of those above described; I have named these hills Baily Range, after my friend W. H. Baily, M.R.I.A., Palæontologist to the Geological Survey of Ireland.

272. A little West of this range are some curious looking white hills, evidently quartz rock, extending some few miles; but these I have not had an opportunity of examining closely.

273. The country in the neighborhood of Mt. Ramsay, and the granitic country to eastward of it, have been already sufficiently described.

274. *Country between Mt. Barrett and Albert-Edward Range partly along the Elvire River.*—This is rather an interesting section. The rocks of Mt. Barrett are principally quartzites and hard grey grits, dipping

generally to N.N.W. at angles of 10° to 40°, and occasionally undulating; the trend of the hill is W.S.W. and E.N.E. On the southern side, the hill shows very precipitous escarpments, some of which are very picturesque; and deep gullies cut laterally into it. A good deal of ironstone and iron sandstone is interbedded in the lower strata.

275. At the base of the mountain there is an extensive outburst of basalt and dolerite, traceable for some miles, and no doubt connected with that noticed near the quartzite hills to the S.W. It is about ¼ mile wide, and forms a low but rugged ridge, following the general trend of the hill.

276. The low ground for a short distance east of this is strewn with pieces of green quartzite, evidently the debris of the underlying rock.

277. Granite then occurs in low but very rugged hills, which enclose the southern extension of the Nicholson Plain. This granite is red in color, and very coarse in texture, and the quartz crystals exhibit a distinct greenish shade.

278. Ten miles from Mt. Barrett the granite is succeeded by quartzites, dipping S.S.E. to S.E. at 80°, and these are followed by schist penetrated by a mass of hornblendic rock, passing in places into syenite, which forms a low but prominent ridge extending for some 10 or 15 miles at least to the N.E. Quartzites, schists, and gneiss crop out freely for some miles, the former showing in high ridges and isolated hills. Continuing eastward; the Elvire, seven miles from its source, is found to pass through a gorge formed in quartzites and grits, with interbedded slates and schists, showing many quartz veins; all the rocks striking generally N.E. (In some of the quartz, in this locality, minute specks of gold were observed.) At J 26 there are very coarse grits which can be traced round the hills to J 25.

279. The Elvire River now runs through a series of rocks, resembling those of the McClintock Ranges, of which beds they are indeed the continuation, namely, green and grey talcose chloritic and micaceous schists and slates, with gneiss, and occasional beds of metamorphosed grit and quartzite. These rocks exhibit so many alternations that it would be an endless task to describe them in detail. Suffice it to say that their section extends for about 15 miles in this district, and shows multitudes of quartz veins and reefs of most promising appearance. In the lower part of this section of the river, these reefs are especially abundant, and taking only the larger ones average over 20 in each mile; in some places more than a dozen in a quarter of a mile. Some of these reefs are very wide, it being usual to see veins 6, 8, and 10 feet in width; and these persistent as far as the eye could follow them.

280. Besides the more prominent reefs noticed above, there are innumerable smaller ones, ranging in width from 6 inches to 2 feet.

281. These reefs run in directions varying from N. 10 W. to N.E. A great number of them run due N. and S. Their direction seems to be determined chiefly by the strike of the rocks, to which they generally accommodate themselves closely; although there are many exceptions, when the reefs are seen to cut across the strata at some inclination to the strike.

282. Basalt dykes and pipes occur in several localities (as marked on the Map), often altering the slates to a hard flinty substance.

283. The Elvire river, in this section, follows a nearly easterly course, that is, speaking generally; for in detail, it winds in and out to north and south in a most puzzling manner, so much so, that in order to reach the Albert-Edward Range, a distance of about 15 miles, we had to travel at least 22.

284. The river takes a sudden turn here to north, and continues in this direction for about a mile under the escarpment of the Albert-Edward Range, along which it might naturally be expected to flow for a long distance. However, it suddenly turns to the eastward and passes through a deep gorge in the Devonian Rocks.

285. It will be an interesting problem for the geologist of the future, who may have time and means at his command, to solve, as to why this river should have cut through an apparently impassable barrier of hard quartzites and grits, when a more easy means of egress seems to be presented in the soft slates and schists to the westward and extending north-east.

286. It is clear that the river gorge must have been at least commenced long before the country possessed its present configuration, and when the ground to the westward must have been much higher than the edge of the grit range now is.

287. Near the entrance to the gorge the slates and schists are much contorted, and dip W. and E. at 70° to 80°, and on the denuded edges of these rocks repose hard quartzose grits which, although only reaching an altitude of about 500 feet, are at least 1000 feet thick. They dip at an angle of 45° to the S.E., and are succeeded by limestone beds of great thickness, 1399 feet as calculated. The limestones are followed by hard grits with red and green schistose slates, and these again by limestone and shales or slates of considerable thickness. These different alternations of strata occur in the short distance of one mile.

288. The strata along the valley of the Elvire below the Crater are chiefly hard, green and blue clay slate, with shale bands resting on limestone and covered by quartz gravel.

289. In the gap near Mt. Kinahan the succession of strata is seen to be similar to that noticed in the gorge, except that there are more alternations of grits and limestone.

290. At Eliot Range the strata are chiefly hard grits and sandstones, often greatly contorted and disturbed by faults, subordinate beds of limestone and slate occur frequently, and at the north side of the range facing J 30 there is a thick band of limestone dipping N.W. at 80°, evidently brought into its present position by means of a large fault.

291. The rocks on each side of this valley have been already fully described.

292. *Section from J 34 to Mt. Coghlan.*—This country was traversed for about 17 miles to the southwest, and proved to be very rough ground, consisting of an apparently interminable succession of rounded and peaked rugged schistose hills *(see* Plate 13.*)* The formation is Metamorphic, being chiefly chloritic and micaceous slates and schists, with occasional beds of gneiss, grits, and quartzites. A few outbursts of coarse basalt and dolerite were noticed at from 3 to 7 miles from J 34. The rocks strike generally N. to N.N.E., and are often much contorted, the dip frequently changing from E. to W. Quartz veins occur in great abundance, and are of the same promising appearance as those noticed to the southward. They usually strike N. to N.N.E.; but in many places there are cross veins running nearly E. and W. Much of the country is perfectly white, owing to the great quantities of quartz scattered over it, and derived from these reefs. I think it most probable that these reefs will be found to yield payable gold, and as there are many streams and gullies often affording permanent pools, there will be no difficulty as regards a necessary water supply.

293. At Mt. Coghlan the rocks are similar to the above, being chiefly slates with many quartz veins, in one of which I observed tiny specks of gold. The summit of the mount is composed of hard quartzose grits containing quantities of black iron sand, which occur in distinct black bands. These rocks strike N.N.E. and dip nearly vertical, with a slight inclination to west.

294. A similar band of grits is seen about 200 yards to the east, and continues for a long distance through the hills.

295. *Section between J 34 and the Base Line camp.*—J 34 is a high precipitous ridge, composed of hard light grey quartzose grits, dipping nearly vertically, and striking nearly N. and S. To the West are the Metamorphic schistose and gneissose rocks of the Panton, and there appears to be a fault of some magnitude between these rocks and the grit mountain, which rises at least 1,000 feet above them. On the east side of this hill there is a very steep precipitous wall of rock, some 300 feet high (*see* Plate 16), and a little further eastwards is a visible fault, by which the more eastern beds have been greatly contorted, these rocks forming a low rounded hill, about 100 feet high, the strata of which roll gently over to E.

296. Still further to the eastward the basaltic formation is seen overlying the Devonian rocks, and rising into high rugged bluffs and escarpments. These rocks have been already referred to in the detailed description. In this part of the district they form a narrow band stretching for some miles to the North and South—but connected with the main mass of basalt constituting the Antrim Plateau,—and about 3 to 4 miles wide.

297. About 3 miles from J34 the basalt disappears under hard flinty flaggy limestone which crops out in rough seams and low cliffs, trending about N. and S., and dipping East at gentle angles of from 5° to 20°.

298. One mile further the limestone is overlaid by well bedded grey and chocolate colored flags with shales and mudstones which appear in the river bed, and also in some low hills a short way to the southward. But from this to the Base Line Camp Z27, there is hardly an exposure of rock except a few beds of red shales and micaceous mudstones in the river bed, the greater part of the district being covered by a thick deposit of river gravel and alluvium.

299. In the Elvire River, a little to the North of where the limestone is seen to overlie the basalt in this section, there is a fine exposure where the river cuts through the different beds, and exhibits the limestone resting on a denuded surface of basalt. The basalt has a distinct dip of 10° to N.E., and the limestone of 5° in the same direction. Section No. 5 will give a general idea of the disposition of the different strata in this direction.

300. *Base Line Camp to Dixon Range.*—The plains on this side of the river are gravelly and rough, with a good deal of spinifex and but little grass, and the underlying rock appears to be altogether of the carboniferous sandstone formation. Two miles from camp the grits and flags show at the surface in frequent patches, dipping to N.E. at 5°, and very regularly bedded. At 3½ miles, in a deep "billabong" or gully, rough grey, white, and red sandstones, and grits, appear, and are occasionally seen in low rises between this and the foot of the hills. All through they must be very close to the surface.

301. Dixon Range is composed of a series of extremely rough and rugged sandstone hills, and is cut up by numerous deep precipitous gullies and gorges. On the whole the appearance of these hills closely resembles that of the St. George Ranges,* and the rock is very similar, consisting of soft white, reddish, and

* *See* Report 1884.

yellow sandstone and grit, with hard grit bands, and some ironstone, all weathering into many fantastic and irregular shapes. Great blocks of rock are strewn over the surface, and form masses of rubbish, resembling moraine drift, on the floors of the deep gorges. For a view of these hills *see* Plates 11 and 12.

302. *Base Line Camp to Hardman Range.*—On this side of the river the prevailing rock is limestone, which crops out from under the alluvium and soil in low ridges bearing a little N. of E. In the present section only one of these ridges is visible. It is about half a mile wide, and has been traced for 10 or 12 miles in a direction to E.N.E., about 2 miles from the river and parallel to it. With this exception the country travelled over was a splendid plain of rich chocolate colored soil, well clothed with Mitchell grass, and thickly timbered, extending for about $8\frac{1}{2}$ miles to the range. The hills are composed of white and yellow soft sandstones, with occasional bands of white indurated grits and some ironstone, and are in every respect similar to those of the Dixon Range, with which they are no doubt coeval.

303. *Section along the Ord River from the Base Line to the Negri.*—There are but few details to add to the general description of this country as given in the preceding pages. On the N.W. are carboniferous grits and shales, and on the South-east the rocks are nearly altogether limestones.

304. About 5 miles below the junction of the Elvire and the Ord, limestone crops out in the river beds, and in low ridges through the alluvium to the south, their general trend being to E.N.E. The rocks are often interstratified with beds of flaggy sandstone and red shales, as at the Nicholson River on the way to J 38, where these rocks are freely exposed, dipping at a low angle to the N.W. They overlie the limestone which forms the country towards the basaltic plateau.

305. On the northern side of the Ord, a good section was obtained on the road from the camp marked on the map Z 31, in a N.N.W. direction nearly. On this route the rocks were seen to be principally, white, grey, and red, flags and grits, with occasional bands of micaceous red shales and mudstones, and a few limestones. The hills (J 38) are of coarse soft white and yellow carboniferous grits.

306. A similar section was observed on the line from the camp near J 40 (in the Mt. Elder Range), towards Mt. John.

307. On this side of the river, low sandstone ranges and hills, such as Doughboy Hill, mark the country, whilst on the other low limestone ranges form the dominant features of the country.

308. The Ord river for a great part of its course (about 40 miles) flows through and over red shales, and micaceous mudstones with flaggy beds, which often rise into high cliffs. The present course of the river seems to have been determined by this band of softer rock, which apparently overlies the limestones on one side, and underlies the grits and sandstones on the other.

309. At the junction of the Ord and Negri, a low ridge of limestone is seen to extend for some miles to the northward, being a spur of the great mass of limestone which occupies the ground to the eastward of the Negri, and continuing south-east in the direction of Mt. Panton. It is a thick bedded hard grey limestone with traces of fossils, and rises in an abrupt but low cliff from the river alluvium. It rests on the basalt which here occupies the bed of the river, and which continues down the Ord for 5 miles (a short distance below J 41 and Mt. Deception), where it is seen in turn to rest on the indurated grits and conglomerates supposed to be of Devonian age. (Plate 24.)

310. Below this the rocks on the Ord are found to belong to the Metamorphic series, viz.:—gneiss, schist, slate, &c.; forming high rough semi-rounded hills, which apparently continue for many miles to the westward. (*See* Plate 25.)

311. The country to the southward along the Negri River, and including Mt. Panton and Mt. Napier, has already been treated of in sufficient detail.

MINERALS AND METALLIFEROUS INDICATIONS.

312. *Ironstone* is one of the most common minerals of the Kimberley District, being found in great abundance amongst the Carboniferous rocks, especially in the sandstone division.

313. It usually occurs as a form of brown hematite, with an admixture of magnetic oxide of iron. It is often a portion of the substance of the rock itself. At other times it is seen in bands which conform to the bedding of the rocks, and again it is not uncommonly noticed forming distinct reefs cutting across the strata.

314. In some places the ore presents a rich appearance; but in the absence of fuel and means of transport it may be looked upon to all intents and purposes as valueless.

315. Thick veins of this ore were noticed in the limestones of Rough Range, and in the sandstones to the east of the Mt. Elder Range.

316. The quantity of iron disseminated throughout the various rock formations of Kimberley is something enormous, and the deposits often assume most fantastic forms; thus, to the South of the

Grant Ranges, near the Fitzroy River, there are low hills of Carboniferous sandstone, on the surface of which rock, and on the lower ground, are strewn quantities of large pieces of rusty ironstone, exhibiting a great variety of artificial-looking structure. Some of these specimens show on the surface most intricately folded and twisted patterns, while others resemble the metal framework of a lattice church window.

317. *Magnetite and Titaniferous Iron.*—These minerals occur plentifully in the sands of most of the river beds, in the form of "black sand," and are then associated with small quantities of tinstone, gold, and fragments of ruby, garnet, pink and yellow topaz, and amethyst.

318. They are also found in many of the stratified rocks, and very abundantly in most of the quartz reefs.

319. Many of the basalts are highly magnetic, and on examination are found to contain a large proportion of magnetite, as in the case of Loadstone hill before referred to.

320. *Copper.*—Carbonate of copper is often met with in the Carboniferous rocks, and occasionally in the Silurian. Good specimens of grey copper ore, mixed with the green carbonate, were obtained from a quartz reef about a mile from J 11 on the Margaret River.

321. *Tinstone* has been found in small quantity in the "black sand" of the river gravels.

322. *Lead, Zinc, etc.*, have been noticed in the form of galena in the limestone rocks a little South of the "Base line" (Ord River); it is associated with zinc blende and contains small traces of silver.

323. Time would not permit of an exhaustive examination of this vast district; but from what I have seen of it I think it extremely likely that the rocks of the country, and the metamorphic rocks especially, contain a great amount of mineral wealth.

324. Of non-metalliferous minerals the following were noticed: Gypsum, Calc-spar, Quartz, Agate, and Moss Agate, Calcedony, Carnelian, Onyx, Garnet, Amethyst, Spinelle or false ruby; Opal, Chrysoberyl, pink and yellow Topaz.

GOLD INDICATIONS AND PROSPECTS OF FINDING THAT METAL IN PAYABLE QUANTITY.

325. I cannot do better than transcribe the remarks on this subject published in my Preliminary Report:

(i.) "I am glad to be able to report that I have discovered a large area of country which I believe will prove to be auriferous to a payable degree. This country is traversed by the Margaret, Mary, Elvire, Panton, and Ord Rivers, and comprises an area of at least 2000 square miles so far as observed, but it doubtless continues over a much greater extent of country. The formation is principally Lower Silurian slate and schist of various kinds traversed by an enormous number of quartz reefs. In some localities many of these occur in the space of a few hundred yards, and it was quite usual to notice 25 or 30 large reefs while riding over a mile of ground, without taking into account the smaller reefs or veins. The quartz constituting these reefs is of a very promising character. It is a dull yellowish and grey quartz, very cellular and vuggy, containing quantities of black and other oxides of iron, together with casts of, and often crystals of iron pyrites. From most of the surface quartz the enclosed minerals have been washed away however, although their traces are still apparent. Minute specks of gold have been noticed in a few cases, and I have very little doubt that many of these reefs, when properly examined and tested, will prove to be auriferous.

(ii.) "These quartz reefs have a general bearing of N. 10 E. to N.E. Many run due N. & S. Some of them can be traced for several miles.

(iii.) "It is most probable that these quartziferous rocks are a spur or continuation of the gold-bearing Metamorphic rocks of the Northern Territory of South Australia, now being worked with some success.

(iv.) "*Alluvial Gold.*—The river valleys and flats are in many places covered with deposits, sometimes very extensive, of quartz-gravel, and drift; the quartz being derived from denudation of the reefs referred to above. I have prospected these gravels over many miles of country, and I have rarely failed to obtain good colors of gold; in many localities of a very encouraging character. Very often good colors were obtained in every pan washed, in different trials in the same locality. I have thus found gold to be distributed over about 140 miles along the Elvire, Panton, and Ord Rivers, &c.; as well as on the Mary and Margaret Rivers, where the indications were very good, and the appearance of the country most favorable.

(v.) "In several instances I obtained good colors of gold at considerable distances from the quartz-bearing rocks from which the gold could only have been derived. This to my mind seems to indicate that there must be large quantities of gold in the quartz-bearing rocks, and in the drifts immediately overlying them.

(vi.) "The gold-yielding country is well watered by numerous rivers, creeks, and gullies, which even in the driest part of the year are never wholly without water. And although during the dry season water is scarce, there would be no difficulty in conserving water anywhere in sufficient quantity for all mining purposes.

(vii.) "On the whole, the indications I have met with point, as I believe, to the great probability of payble gold being obtained in this part of Kimberley, and are I consider sufficient to justify the expenditure, either by the Government or private individuals, of a reasonable sum of money in fitting out a party to thoroughly test the country, and I should strongly recommend such an undertaking. I would also suggest the advisability of parties going up for this purpose providing themselves with some simple apparatus for crushing and washing some of the reef quartz, as in one very rudely conducted experiment of this kind I obtained a small quantity of gold."

326. The principal reef-bearing country extends on the east of the watershed between the Ord and Margaret Rivers. It has been traced from about Latitude 16° 45′ S. to nearly 19° S., and as the alluvium and river gravels have yielded good colors of gold whenever they could be tested, which was generally at every camp, there can be no doubt that many of the reefs are gold-bearing.

327. Excellent colors were obtained in several localities on the first portion of the Elvire, which passes through these rocks.* And in the lower portions in the gravels resting on the Devonian rocks, colors were obtained in almost every place tried.

328. At the junction of the Panton and Elvire, near J 34, good colors were obtained in several places. Just south-west of J 34, I sunk several holes and obtained large specks of gold in every pan washed out.

329. On the Ord River, although far from the slate country, from which alone the gold is likely to have been derived, I obtained from the river gravels good colors in many places, down to where we left off work near Mt. Deception.

330. Here the slate rocks with quartz reefs come in again, and appear to continue for a long distance to the N.W. and N.E., as indicated on the map.

331. The gravels along the Ord and Elvire are full of fragments of quartz, containing a good deal of black iron sand and some pyrites.

332. Some of the quartz collected near J 28, on the Elvire, was roughly crushed in a very primitive manner on a large stone, by means of an axe head; and the result being washed, yielded some specks of gold. Gold was also observed in very tiny specks in a quartz reef at Mt. Coghlan, and in one near J 26, on the Elvire.

333. About 3 miles from the last station, on the road to J 27, numerous quartz reefs are seen, and the ground is strewn for some miles with a thick deposit of quartz gravel, which, to my great regret, I was not able to examine.

334. I have previously mentioned the fine appearance of the quartz reefs in the country near Mt. Dockrell and J 22. At Syenite camp, on the Mary River, which drains a great part of this district, I found in the river gravels excellent indications. I had only time to wash out two pansful, and in both I found several pieces of shotty gold.

335. In the Margaret River, close to J 11, I found faint colors. The washing here, however, was accomplished under very unfavorable circumstances, and with better facilities I should expect good results, as the rock indications are very promising. The possibly metalliferous character of the Metamorphic rocks of this district, which extend for many miles along the south of the Leopold Ranges (*see* Map), has been already commented upon. In all likelihood they are auriferous in places. They occupy, however, but a secondary position when compared with the immense extent of reef-bearing slate country to the eastward.

336. As a guide to those who are likely to take an interest in following up the indications which I have been able to obtain, I have marked the principal reef-bearing and gold-yielding districts with gold lines and gold dots respectively. The country below the Crater Pass in Albert-Edward Range, along the Elvire and the Ord to Mt. Deception, is exclusively alluvial, over-lying Devonian rocks in which no quartz reefs of any size occur. Some of these gravels, which have been already described (*see ante*, General Description, *River Gravels*, par. 86) are not unlikely to contain payable gold.

337. I have great hope that this district will prove a success as regards payable gold, and I trust it will not be very long before the part of the country I have indicated will be subjected to a more thorough and searching examination than, in the short time and with the small means at my disposal, I was able to give it. Intending prospectors must, however, be prepared to expend and perhaps lose money; but the appearances are quite good enough to justify this risk.

EDWARD T. HARDMAN,
Government Geologist.

* Extremely good indications were met just West of the gorge in the Albert-Edward Range so often referred to.

Appendix.

COLLECTION OF ROCKS AND MINERALS.

KIMBERLEY, 1883.

(The numbers refer to their present disposition in the cases in the Geological Museum at Fremantle.)

H 1.—Porphyritic Granite, from Bald Rock, Margaret River.
,, 2.—Granite (Metamorphic), from Small Hill, South of Margaret River.
,, 3.—Granite (Metamorphic), from Granite Hills, East of last locality, near Mt. Krauss.
,, 4.—Granite (probably Metamorphic), South-west of H65, Lennard River.
,, 5.—Coarse Dolerite, from a dyke at first Dinner Camp, River bed, Lennard River.
,, 6.—Gneiss, from Granite Hills, South of Margaret River, near Mt. Krauss.
,, 7.—Schistose Gneiss (red), same locality.
,, 8.—Hornblendic Rock, same locality.
,, 9.—Gneiss, River Lennard, 10 miles East of Devil's Pass.
,, 10.—Dolerite, Basalt Hill, South of Stewart River.
,, 11.—Duplicate of No. 5.
,, 12.—Fine grained Dolerite or Diorite, Lennard River.
,, 13.—Diorite from first Metamorphic Range, about 2½ miles East of Devil's Pass.
,, 14.—Fine grained Metamorphic Syenite, from Hills near Granite Hills, Margaret River.
,, 15.—Andalusite Schist, same locality.
,, 16.—Schistose Hornblendic Rock, same locality.
,, 17.—Fine grained Hornblendic Gneiss, same locality.
,, 18.—Fine grained Schistose Gneiss, last camp on Richenda River, 5 miles above H 65.
,, 19.—Greenstone Porphyry or Dolerite, from West side of Metamorphic Ranges, Lennard River, same as No. 13.
,, 20.—Hornblendic Rock, from debris of hills East-north-east of last camp on Richenda River.
,, 21.—Gneiss, Lennard River about 10 or 12 miles above (East of) Devil's Pass.
,, 22.—Garnet Schist, from Metamorphic Ranges, about 2½ miles East of Devil's Pass.
,, 23.—Talc Schist, river bed near last locality, contains Garnets.
,, 24.—Talc Schist with Staurolite, from river head, Lennard River.
,, 25.—Fine grained Hornblendic Schist, last camp on Richenda River.
,, 26.—Gritty Micaceous Schist, same locality.
,, 27.—Compact Schistose Gneiss, same locality.
H 28.—Quartzite, from Round Hill, Usborne Ranges.
,, 29.—Altered Grits, Leopold Ranges, near Mt. Philip.

CARBONIFEROUS ROCKS.

,, 30.—Fossiliferous Limestone, Mt. Pierre.
,, 31.— Ditto, ditto.
,, 32.— Ditto, ditto.
,, 33.— Ditto, ditto.
,, 34.—Ferruginous Limestone, Oscar Range.
,, 35.—Limestone Agglomerate, ditto.
,, 36.—Stalactite, from Mt. Pierre.
,, 36*a*.—Limestone, from Devil's Pass.
,, 37.—Ditto, ditto.
,, 38.—Ditto, ditto.
,, 39.—Ditto, ditto.
,, 40.—Fossiliferous Limestone, from the Lennard, 4 miles below Devil's Pass.
,, 41.—Limestone, from Geikie Range.
,, 42.—Chert, from a boulder in conglomerate, at Small Hill, West of Brooking's River.
,, 43.—Ditto, ditto.
,, 44.—Ditto, ditto.
,, 45.—Iron Sandstone, from same locality.
,, 46.—Ironstone, South-east of Mt. Abbott.
,, 47.—White Sandstone, small hill North-east of Mt. Campbell.
,, 48.—Iron Sandstone, from locality 42.
,, 49.—Limestone and Ironstone, from Rough Range.
,, 50.—Iron Sandstone, from Duke's Dome.
,, 51.—White Sandstone, Mt. Wynne.
,, 52.—Earthy Agglomerate, small hill, South of Mt. Abbott.
,, 53.—Various specimens of Sandstone, from Mt. Abbott.
,, 54.—Earthy Agglomerate, from Mt. Abbott.
Ha 1.—Iron Sandstone, River bed, near "Cowcher's Camp," May River.
,, 2.—Ditto, ditto.
,, 3.—Iron Sandstone, Poulton's Camp, River May.
,, 4.—Ditto, ditto, same locality.
,, 5.—Ditto, ditto.
,, 6.—Indurated Claystone, same locality.
,, 7.—Ditto, ditto.
,, 8.—Ironstone, Mt. Marmion.
,, 9.—Coarse indurated Grit, same locality.
,, 10.—Ditto, ditto.

COLLECTION OF ROCKS AND MINERALS.

KIMBERLEY, 1884.*

H b 1.—Grits and Quartzite, 1 to 2 miles below J 11.
,, 2.—Calcite, from J 27.
,, 3.—Quartzose Grit, same locality.
,, 4.—Trachy-dolerite, with Devonian Grit enclosed, Mt. Napier.
,, 4a.—Ditto, ditto, with much green Silicate of Iron, same locality.
,, 5.—Felspathic Schist (white) with Quartz, from near Syenite Camp.
,, 6.—Fine grained Anamesite with Quartz and Olivine, near Syenite Camp.
,, 7.—Coarse Hornblendic Rock, same locality.
,, 8.—Red Granite (Syenitic Granite), same locality.
,, 9.—Schistose Grits, &c., from Mt. Dockrell.
,, 10.—Granitoid Gneiss, from road between Syenite Camp and Mt. Dockrell.
,, 11.—Syenitic Granite (red), from J 56.
,, 12.—Epidote rock, and Epidote occurring in veins in above, same locality.
,, 13.—Syenitic Granite (black), same locality.
,, 14.—Granite, near Mt. Huxley.
,, 15.—Hornblendic Schist, near junction with Basalt, Elvire and Panton Rivers.
,, 16.—Quartz, from Basalt, 2 miles East of J 34.
H b 17.—Green Jasper, J 40, several specimens.
,, 18.—Red and striped Jasper, J 42, last camp Ord River, near Mt. Deception.
,, 19.—Devonian Grits, Mt. Bertram.
,, 20.—Limestone, same locality.
,, 21.—Granite, camp 7 miles South of Mt. Barrett.
,, 22.—Altered Slate in close proximity to Basalt, near J 27, camp of June 26.
,, 23.—Basalt, same locality.
,, 24.—Chloritic and Talcose Slates, from Gorge close to J 26.
,, 25.—Coarse Grit, from summit of Hill same locality.
,, 26.—Basalt, from junction of Panton and Elvire Rivers.
,, 27.—Limestone with Lead, Zinc, and Fossils, from River South of Base Line Camp, several specimens.
,, 28.—Calcite collected by Mr. Johnston between Mt. Huxley and J 9.
,, 29.—Syenite and Syenite Porphyry, from Syenite camp.
,, 30.—Basalt, from Junction of Panton and Elvire.
,, 31.—Grits, Mt. Huxley.

* NOTE.—No attempt has been made to arrange these specimens systematically.

APPENDIX.—*continued.*

H b 32.—Quartzite, Mt. Huxley.
" 33.—Fossiliferous Limestone, from Mt. Panton, several specimens.
" 34.—Chloritic Schist, Camp October 11, 6 miles West of J 11.
" 35.—Siliceous Vein Stuff, from same locality.
" 36.—Grits, &c., from J 59.
" 37.—Agate or Calcedony, from Mt. Frank.
" 38.—Calcite, with carbonate of lead, from near J 13.
" 39.—Coarse Granitoid Rock, from neighborhood of F 141, about 6 miles E. of J 11, on Margaret River.
" 40.—Fine-grained Epidotic Granite, same locality.
" 41.—Syenitic Rock, passing into Hornblende Rock, Margaret River, below Mt. Krauss.
" 42.—Granitoid Gneiss, Margaret River above J 11.
" 43.—Fine-grained Basalt, from River Ord, one mile below last camp, near Mt. Deception.
" 44.—Schistose Rocks, from a little below last locality.
" 45.—Granitoid Hornblendic Rock, from River Margaret, above J 11.
" 46.—Fossiliferous Agate, from J 40.
" 47.—Jaspers, from last camp on River Ord, near Mount Deception.
" 48.—Fossiliferous Limestone, river bed Ord, near J 38.
" 49.—Carboniferous Breccia, from J 8.
" 50.—Schist and Quartz, neighborhood of Mt. Dockrell.
" 51.—Trachy-dolerite, from Great Antrim Plateau.
" 52.—Hornblendic Schist, on the road from Syenite Camp to Ramsay Range.
" 53.—Granite, same locality.
" 54.—Grits and Quartzose Sandstone, highly indurated, J 13, Devonian.
" 55.—Similar Rocks and Purple Slate, Silurian, J 10.
" 56.—Trachy-dolerites, from near Mt. George.
" 57.—Coarse Dolerite, from last camp, near J 27, Elvire River.
" 58.—Dolerite with Asbestos and Magnetic Iron Ore, several specimens from Loadstone Hill.
" 59.—Crystalline Limestone (Silurian), near Mt. Dockrell.
" 60.—Quartz specimens, same locality.
" 61.—Quartz with Hornblende, &c., between Syenite Camp and J 23.
" 62.—Quartz, with various iron oxides, &c., from Mt. Dockrell and on the road to Laugher's Camp.
" 63.—Grit and Foliated Schistose Grit, from J 33.
" 64.—Syenite Rock (Black), from Margaret River, near J 11.
" 65.—Carboniferous Grits, from J 36 (Hardman Range).
" 66.—Devonian Limestone, from Crater Camp.
" 67.—Quartz, from near J 22.
" 68.—Agate and Calcedony, from T 16 (Mary River).
" 69.—Basalt, &c., between J 26 and J 27 (Elvire River).
" 70.—Quartz, from a reef about 6 miles N.N.E. of Syenite Camp.
" 71.—Agate, Opal, and Moss Agate, near Laugher's Camp.
" 72.—Basalt, near Mt. Napier.
" 73.—Quartz, from Basalt, near Mt. Napier.

HB. 2. 1.—Granite, about 7 miles South of Laugher's Camp.
" 2.—Granitoid Rock, same locality.
" 3.—Fossiliferous flint with *Planorbis Hardmani* (McCoy), from J 40.
" 4–7.—Grits, &c., from Mt. Bertram (Devonian).
" 8–9.—Basaltic Lava with Grit, from Mt. Napier.
" 10.—Limestone, from "Crater."
" 11–12.—Grits, from "Crater" and J 28.
" 13–14.—Argillaceous Slate (Devonian), River Bed at Camp J 28
" 15.—Quartz, from J 22.

HB 2 16.—Carboniferous Sandstone, J 36 or J 37.
" 17.—Ditto ditto.
" 18.—Carboniferous Limestone, from Ridge to South of Base Line.
" 19.—Granite, J 57.
" 20.—Basalt or Diorite, same locality.
" 21.—Hornblendic Rock.
" 22.—Hornblendic Schist, Elvire or Panton Rivers.
" 23.—Gneissose Rock, Louisa River.
" 24.—Hornblendic Rock, on the road to J 8, from Mt. Huxley.
" 25.—Partially decomposing Syenitic Rock, same locality.
" 26.—Coarse Dolerite, from Margaret River, near J 11.
" 27.—Epidotic Rock, from Basalt, same locality as 26.
" 28.—Ditto, with Quartz.
" 29.—Devonian Limestone, river bed, J 30.
" 30.—Devonian Grit, same locality.
" 31.—Limestone, 3 miles North of Camp Z 31, S.S.E. of J 39.
" 32.—Limestone with Fish Palate, Camp Z 31, river bed Ord.
" 33.—Basalt, J 11.
" 34.—Diallage Rock, from gorge, 1 mile below Camp at J. 11.
" 35.—Trachy-dolerite, from ½-mile West of last Camp on the Ord, with prase.
" 36.—Ditto ditto.
" 37.—Fossiliferous Grits, from near Grant Range, April, 1884.
" 38.—Fossils, from River Fitzroy, S. 15° E. of Mt. Abbott.
" 39.—Calcareous Grit with carbonate of lime, blende, and zinc, from camp at Lake Joceline.
" 40.—Basaltic lava and tuff, from Mt. Deception.
" 41.—Jasper, from camp on Ord, near Mt. Deception.
" 42.—Quartz *var. prase*, from last camp, Ord (Mt. Deception).
" 43.—Agate with crystals of Topaz, near T 11.
" 44.—Agates, from J 38.
" 45.— Ditto, ditto.
" 46.— Ditto, ditto.
" 47.—Basalt and lava, same locality.
" 48.—Quartz, from basaltic rocks, same locality.
" 49.—Limestone, Devonian, from J 56.
" 50.—Limestones, from J 56, Devonian.

Fossils.

HB 3 1–4.—Fossils, from Mt. Pierre.
" 5.— Ditto, ditto.
" 6.—Fossils from J 5, with *Chætites tumidus* from Hills west of Mt. Pierre.
" 7–14.—Fossils from Carboniferous Limestone of Mt. Krauss and opposite hill Margaret River.
" 15–18.—Carboniferous Limestone Fossils collected in Rough Range, exact locality uncertain.
" 19–25.—Carboniferous Fossils from Rocks to North of Mt. Joceline.
" 26–34.—Carboniferous Fossils, from Liverynga near Mt. Anderson.

" 35–37.—Specimens from various places on road from J 26 to camp 7 miles South of Mt. Barrett.
" 38–39.—Specimens from camp South of J 27.
" 40–42.—Grits, &c., 2 miles below J 11.
" 43–44.—Syenite, Basalt, Epidote, and Quartz from J 56.
" 45.—Porphyritic Syenite, Syenite Camp.
" 46.—Variety of same, same locality.
" 47.—Epidote in Syenitic Rock, same locality.
" 48.—Dolerite and Anamesite (fine-grained Dolerite) with quartz, East of Syenite Camp.
H.B. 2 51.—Grit (Devonian), from J 59.
" 52.—Granitoid Gneiss, from Margaret River, near J 11.
" 53–54.—Trachy-dolerite, from J 32.
HB. 3 49.—Indurated Clayslate (Argillite), J 11.
" 50.—Coarse Granite, from road to J 8 (collected by Mr. Johnston)

APPENDIX.—*continued.*

HB. 3 51.—Carboniferous Conglomerate, from J 8, (Johnston).
,, 52.—Agate, from Mt. Frank.
,, 53.—Quartz, ditto.
,, 54.—Hornblendic Chlorite Schist, locality lost.
HB. 4 1.—Gneiss, from road between J 10 and J 11.
,, 2.—Quartz with Iron, same locality.
,, 3.—Talcose Slate, from Mt. Coghlan.
,, 4, 5, 6.—Specimens of Quartz, same locality.
,, 7, 8.—Basalt and Trachy-Dolerite, from last Camp, Ord.
HB. 4 9, 10.—Diorite from Gully close to Mt. Huxley, containing many minute specks of metalliferous minerals, like Pyrites (white), and possibly Antimony.
,, 11.—Quartzose Grits, from J 30.
,, 12.—Ditto, very coarse, colored with Iron, same locality.
,, 13.—Coarse Green Rock with Quartz, like Hornblendic Syenite, from road from Mt. Huxley to J 8.

LIST OF ILLUSTRATIONS.

1.—Camp in the bed of the Margaret River near Ramsay Range.
2.—Limestone resting on Basalt, near J 38.
3.—View of the Leopold Ranges, from Mt. Pierre, looking East.
4.—View of Mt. Napier and Antrim Plateau, from Mt. Panton.
5.—View from J 39, looking N.E., showing Mts. Glass and Buchanan. Devonian hills in distance.
6.—View of Albert-Edward Range, from J 22.
7.—"The Crater," looking N.
8.—View of country South of Elvire River, from J 25.
9.—Mt. Barrett, from Quartzite hills to S.W.
10.—View near Mt. Deception, showing Jasper resting on Basalt.
11.—Panoramic view of the Mueller Range, from Ramsay Range, looking N.W.
12.—First view of the Ord River and Plains, from Dixon Range.
13.—Panoramic view of the Panton district, from J 34, looking S. to S.W.
14.—Panoramic view of Great Antrim Plateau, from Mt. Napier.
15.—Erecting a "Trig." Station on Rough Range.
16.—Precipice, East side of J 34.
17.—View near entrance of gorge in Leopold Ranges, Upper Margaret, showing Quartzites upheaved by mass of Basalt.
18.—Near the Western entrance of "the Gorge," Albert-Edward Range.
19.—Flora Valley, Elvire River, near Crater Camp.
20.—A Pool on the Elvire River, Eliot Range in distance.
21.—River Bed Elvire (Panton), Dixon Range in distance.
22.—Caroline's Pool.
23.—Permanent Brook near Mt. John, Devonian Grits.
24.—View on the Ord River below Mt. Deception, showing Metamorphic, Devonian, and Basaltic Rocks.
25.—Last glimpse of the Ord, below Mt. Deception.
26.—Deep Permanent Pond at Liverynga (proposed townsite) Lower Fitzroy River.

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Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

Pl. 1.—Camp in the bed of the Margaret River near Ramsay Range.

Dr. by H. C. P., from Sk. by E. T. H.

Albert Edward Range.

Basalt.

Pl. 2.—Carboniferous Limestone resting on Basalt, near J 38.

Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

MT. HUXLEY.

MT. PIERRE.

MT. BALL.

Carboniferous Limestone

Pl. 3.—View of the Leopold Ranges, from Mt. Pierre, looking East.

Dr. by H. C. P., from Sk. by E. T. H. Carboniferous Sandstone and Limestone.

Pl. 4.—View of Mt. Napier and the Basaltic Range, from Mt. Panton.

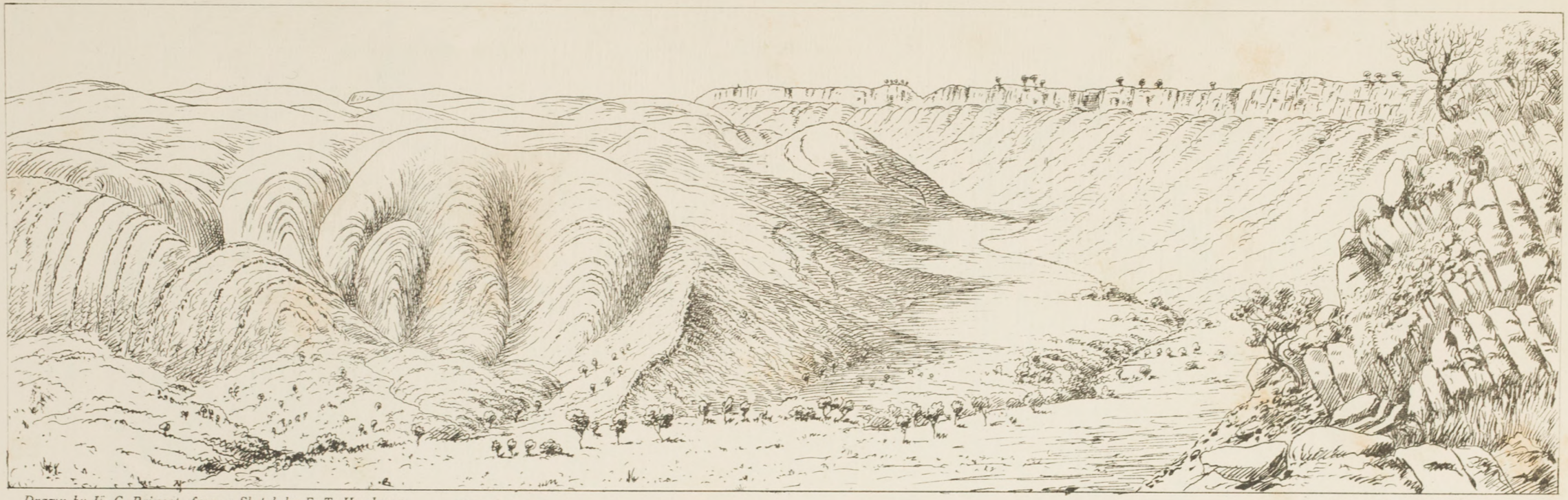
Dr. by H. C. P., from Sk by E. T. H. Carboniferous Limestone.

Pl. 5.—View looking N.E. from J 39 (Carboniferous Limestone), showing isolated sandstone hills, Mt. Glass, &c. Devonian Hills (A. E. Range) in distance.

Dr. by H. C. P., from Sk. by E. T. H.

Pl. 6.—View of Albert-Edward Range, from J 22.

Showing extension of Metamorphic Grits and Slates.



Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

Pl. 7.—The Crater (Albert-Edward Range).

Dr. by H. C. P., from Sk. by E. T. H.

Pl. 8.—View of country South of Elvire River, from J 25, looking S.

Metamorphic Rocks, Schists, Grits, Quartzites, &c.

Quartzites and Metamorphic Grits.

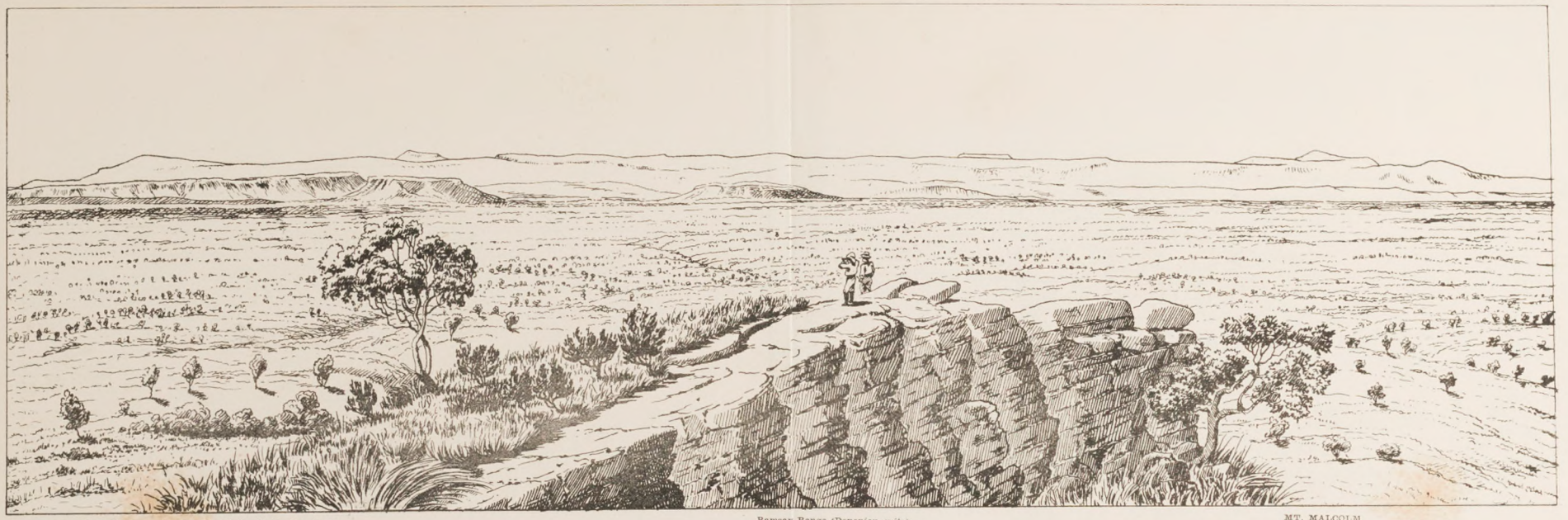
Dr. by H. C. P., from Sk. by E. T. H.

Pl. 9.—Mt. Barrett, from Quartzite hills to S.W.

Quartzites and Metamorphic Grits.

Pl. 10.—View across the valley of the Ord, near Mt. Deception, showing Jasper resting on Basalt.

J Jasper B Basalt C Devonian Grits



Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

Pl. 11.—Panoramic view of the Mueller Range, from a part of Ramsay Range.

Middle ground Devonian Slates and Flags.

Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

Pl. 12.—First view of the Ord River and Plains, from Dixon Range.

Pl. 13.—Panoramic view of the Panton District, from J 34, looking S.W.
Country chiefly Metamorphic Schists, Slates, &c. Hills to left and immediate foreground, Devonian.

Pl. 14.—Panoramic view of the Great Antrim Plateau, from Mt. Napier, looking S. to S.W.

Dr. by H. C. P., from Sk. by E. T. H Carboniferous Limestone

Pl. 15.—Erecting a "Trig." Station on Rough Range.

Dr. by H. C. P., from Sk. by E. T. H.

Devonian Grits

Pl. 16.—Precipice, East side of J 34, Albert-Edward Range.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Pl. 17.—View near entrance of Gorge in Leopold Range, Upper Margaret R.

Showing Quartzites upheaved by mass of Basalt.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Pl. 18.—Near the Western entrance of "the Gorge," Albert-Edward Range.

Metamorphic and Devonian

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Devonian Grits and Limestone.

Pl. 19.—Flora Valley, Elvire River, in "the Gorge," near Crater Camp, Albert-Edward Range.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Pl. 20.—A Pool on the Elvire River, Eliot Range in distance.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Pl. 21.—River Bed Elvire (Panton), Dixon Range in distance.

Dr. by H. C. P., from Sk. by E. T. H.

Pl. 22.—Caroline's Pool.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Devonian Grits

Pl. 23.—Permanent Brook near Mt. John.

Drawn by H. C. Prinsep, from a Sketch by E. T. Hardman.

Basalt

Devonian

Silurian Metamorphic

Devonian

Basalt in foreground

Pl. 24.—View on the Ord River N.E. of Mt. Deception.

Silurian, Devonian, and Basaltic Rocks.

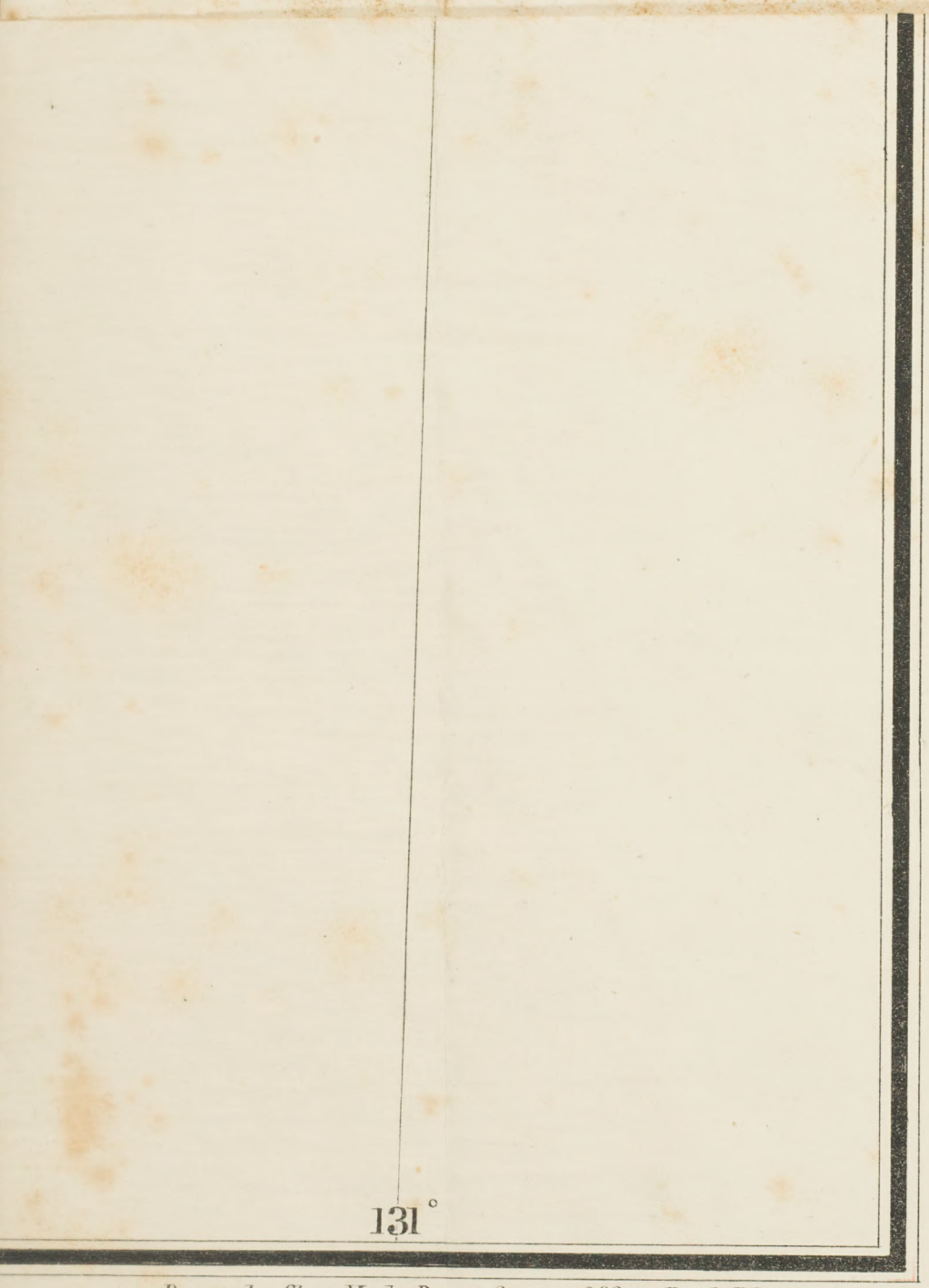
Drawn by Margaret E. Forrest, from a Sketch by G. J. Hardman

Pl. 25.—Last glimpse of the Ord River, below Mt. Deception.

Metamorphic Rocks, Gneiss, Slate, &c.

Drawn by Margaret E. Forrest, from a Sketch by E. T. Hardman.

Pl. 26.—Liverynga.



Drawn by Chas: Youle Dean, Survey Office, Perth, Western Australia.