SOUTH AUSTRALIA.

EXAMINATION OF COUNTRY NORTH-EAST OF EUCLA.

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REPORT and JOURNAL of EXAMINATION of the COUNTRY NORTH-EAST of EUCLA, by Mr. JAMES W. JONES.

REPORT.

Adelaide, 22nd September, 1880.

Sir—Having completed the duty entrusted to me by your letter of instructions of the 15th March, 1880 (S G.O., 955/80), to examine the country on the west boundary of this province in the vicinity of Eucla, with the view of selecting a site for the first trial borings for water, and your subsequent instructions by wire, to complete the examination of Nullarbor Plain.

I have now the honor to submit a plan, showing a complete description of the country from the coast to the route taken by Mr. Ernest Giles on his exploration trip to Perth, Western Australia.

The plan embraces the entire extent of that portion of Nullarbor Plain within South Australia covering an area of 16,500 square miles.

My official journal gives a minutely-detailed description of the country passed over, with records of various observations. A condensed copy, omitting observations, &c., is annexed hereto.

It will be seen that this hitherto comparatively unexplored country has been thoroughly examined.

I found that in many important particulars the surmises in previous reports respecting this country were not borne out.

Rainfall.—Instead of evidence of a gradually decreasing rainfall inland, my descriptions of the herbage on various parts of the plain, but particularly on the northern side, prove, I think, conclusively that for the earlier part of this year at least, the rainfall has been much larger than on the coast. Some parts—and that immediately outside the coast timber as much as any—were rather dry; but evidence of considerable local showers was invariably met with a little further on.

My impression is, that the north side of the plain has a fair general rainfall, almost, if not quite equal to the seaboard, and that in most years the whole of the plain shares in a rainfall sufficient to keep the salt, cotton, and other good bushes in fair growth. From the nature of the soil a few inches of rain will not only do this, but also bring up a good growth of succulent herbage.

An appendix shows the rainfall at Eucla, as recorded at the telegraph station for the last five years, from which it will be seen that the average of the four years, 1876 to 1879, is 10·628 inches, or omitting 1878, which was an unusually dry year throughout this and many other parts of the colony, the average reaches 12·046 inches.

The fall at Eucla for the first seven months of this year was 5·989 inches, and the average of the previous four years for the same months 7·718 inches, this is inclusive of the unusually dry year. It cannot be said, therefore, that I have seen the country at an unusually favorable time.

Shrubs and Herbage.—Some comparatively small portions of the plain are occupied by shrubs of very little value, such as broomlike eremophila and different varieties of blue bush; but for the most part there is a thick growth of good sheep bushes, such as salt and cotton bush, which uniformly cover the ground. In different places throughout the plain a considerable extent of very good green herbage was met with, and generally on the north side the herbage and grass were very luxuriant. I do not think, however, that in most parts there is ever very much grass.

On my last trip across the plain towards Ooldea, after leaving the coast timber and passing the furthest point reached by Professor Tate, the herbage and bushes, which were rather dry and scanty at first, gradually improved, and in a few miles the saltbush was in very good healthy growth, and with excellent green herbage and grass thickly clothed the ground. This continued for fully 20 miles.

In my opinion the entire area is more or less adapted for sheep if a permanent supply of water is obtained.

Surface Soil.—Although there are parts where the rock approaches very near the surface, and even frequently exposed, yet on the whole the entire area has a fair depth of rather friable loamy soil, with many extensive valleys and flats of rich red loam from two to three feet deep. I need hardly say that there is no soil of a sufficiently retentive nature for dams.

Rocks.—The whole area of this part of Nullarbor Plain is occupied by crystalline limestone, with marine fossils. This was ascertained from examination of the very numerous caves and blowholes, and the wells sunk near the Bight, and those at Ooldea, and near Pedinga. The first-mentioned pass through strata, identical with the coast cliffs. Salt water being found at from 160ft. to 174ft. from surface, in white chalky limestone. The wells sunk by Mr. Crawford at Ooldea commence in white fossiliferous crystalline limestone, with a band of yellow crystalline limestone with quartz grains, and are bottomed in very fine yellow quartzose sand and clay, at depths from 72ft. to 80ft., where salt water was struck. I should judge the limestone to have occupied half the depth. The white chalky limestone of the cliffs is absent. The

The same description of limestone occurs in the wells sunk by Mr. Matthews between Pedinga and Colona; the chalky limestone is absent here also. Salt water was found in yellow quartzose sand.

At Pedinga the plain is terminated by disturbed hilly country. Metamorphic rocks rise to the surface very irregularly, with strike of 22° to 60° east of north and very high inclination to the eastward.

Passing north of Ooldea, and crossing a considerable range 650ft. above sea level, I examined two wells recently struck by Mr. Tietkins.

The older limestone of Nullarbor Plain is entirely absent. The wells are commenced in hard compact limestone with concentric black markings, which gives place to siliceous and calcareous sandstone, clays, iron bands, black sand, and white micaceous clay, with small lumps of mundic. Slightly brackish water was struck in the black sand at 100ft., but on going deeper into the white clay the water became very brackish (sample herewith). The wells east of Tallowan to Fowler's Bay, so far as I could learn, or judge by spoil heaps, commence in compact and crystalline limestone, and the water almost invariably struck in sand or clay. The white chalky limestone of the cliffs is, I think, almost if not entirely absent.

The very numerous caves, blowholes, and fissures in the Nullarbor crystalline limestone formation make it very porous to water.

Ooldea.—Ooldea water is merely the drainage from a ring of sandhills 50ft. high, encircling an area of about 150 acres; ten acres in the bottom of this basin is nearly level, and the water is found at a depth of 3ft., resting on a bed of red and blue clay. The water is perfectly fresh, but a little hard. The supply cannot be fairly tested by the two small wells at present existing, but I do not think it is sufficient for more than a few horses or cattle.

Levels.—The country invariably rises gradually from the sea cliffs. The north side of the plain near the Province boundary was estimated to be 600ft. above sea level. The north side of the plain reached on second trip estimated at 450ft. and the plain at Ooldea 250ft., Ooldea range 650ft., and the plains northwards near Tietkins wells 400ft.

Site selected for first trial Well.—Finding the whole of the plain occupied by the crystalline limestone formation, with an invariable fall, more or less, towards the sea, I concluded that a site near the edge of the coast timber would be as favorable as any other for the first trial well, and would have many advantages not to be met with in other places.

Bearing in mind the approximate position indicated in your letter of instructions, I decided upon the general locality, and looked about for the deepest natural pipe in the hard rock. After examining several I eventually decided to recommend Albala-Karoo, near the telegraph line, about 44 miles E.N.E. of Eucla, and 11 miles from the sea cliffs.

I consider it equal to any as regards formation and levels. The surface falls towards the sea cliffs about 4ft. in a mile, the cliffs immediately south being 252ft. high (a section is shown on plan), and the well site 294ft. above sea level.

The formation seems identical with the cliffs.

From an economical point of view this site is, I think, before any other, for several reasons.

The natural hole is almost vertical for 72ft., and therefore passes through the hardest stratum of rock, and with a little enlargement can be used for the well shaft.

It is surrounded by timber suitable for fuel for the engine, and is, I think, in a good position—should fresh water be obtained—to further the development of the country beyond, as well as making the local good country available, for without a well it must remain unstocked, the nearest water being a very small supply at Merdeyarrah sand-patch, on the coast, 33 miles south-westerly.

As to the prospect of obtaining water on the artesian principle by boring below the upper water, I think it is difficult to judge with any certainty, and nothing less than boring will satisfactorily solve the doubt. Even with a remote chance of success, the country, in my opinion, would justify the attempt.

I certainly think the site selected a fair test of most, if not the whole, of this formation; and if good water is obtained here I venture to say that it may safely be expected in most wells; but if, on the other hand, the results of drilling are unfavorable, I cannot recommend any further operations with the machine on the Nullarbor Plain. It is just possible, however, that a difference in quality of the *upper* water may exist. I think this can be best tested by sinking ordinary well-shafts.

I have brought with me specimens of the various rocks.

I have, &c.,

The Surveyor-General, Adelaide.

JAMES W. JONES, Chief Surveyor.

APPENDIX TO REPORT.

Rainfall at Eucla, as recorded at Telegraph Station.

[Kindly supplied by C. Todd, Esq., C.M.G.]

Month.	1876.		1877.		1878.		1879.		1880.	
	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.
January	3	0·580	2	0·100	0	0·000	6	0·050	2	0·126
Ferbuary	2	0·020	5	0·790	4	0·138	4	0·064	1	0·046
March	7	4·820	3	0·070	5	0·690	3	0·663	13	3·371
April	7	0·430	10	8·070	5	0·350	6	0·767	9	0·553
May	11	2·400	9	1·650	5	0·738	15	0·944	8	1·361
June	7	0·370	6	0·630	17	1·058	7	0·652	3	0·070
July	6	0·920	8	0·930	13	1·020	17	2·158	11	0·462
Total for seven months ..	43	9·540	43	12·240	49	3·994	58	5·298	47	5·989
August	6	0·410	3	0·145	5	0·335	8	2·371	—	—
September	5	0·350	6	0·185	5	0·636	10	0·938	—	—
October	3	0·410	2	0·110	4	0·698	7	0·182	—	—
November	3	0·570	5	0·160	1	0·145	10	2·096	—	—
December	2	0·050	6	0·930	5	0·565	5	0·104	—	—
Total for year	62	11·330	65	13·770	69	6·373	98	10·989	—	—
Average per year								10·615		

JOURNAL.

Proceeded to Eucla in the schooner *Grace Darling*, accompanied by Mr. Thomiar with his party and drilling machinery and appliances, capable of attaining a depth of 1,500ft. if necessary. We reached our destination on Monday, 5th April, 1880, having made the quick passage of five days from the Semaphore.

I was most favorably impressed with the place, and saw at a glance that no great difficulty would be experienced in landing even our heaviest pieces of machinery, the bay being exceedingly calm, notwithstanding almost a gale at sea the day before.

The vessel anchored in two and a half fathoms, about a quarter of a mile off shore, and opposite the landing-place, which is on a fine-grained sandy beach, sufficiently hard at low water for the camels and wagons to pass over without sinking. A fair depth of water for boats continues to within a boat's length of the beach, and during the whole time there was no break to cause a moment's delay in landing, which was commenced the next morning, and continued uninterruptedly until the last package was ashore—even the boiler, which was taken complete on its own wheels, and weighs $2\frac{3}{4}$ tons, was landed without any difficulty. The beach is skirted by white sand dunes, about ten chains in width, over which a track has been made, but the sand is very soft and heavy.

The camels proved their capability in harness, by taking loads of about two tons at a time on each wagon over the soft sand, and subsequently by heavier loads, on a rough road, with a gradient of one in six, over the cliffs to the table land.

Having seen the heaviest parts of machinery landed, and arranged for the transport inland to be proceeded with under Mr. Thomiar's supervision, I prepared to start on a short exploration trip.

As I intended making an effort to find the remains of poor Fairie and Woolley, who, it will be remembered, are supposed to have perished for want of water, on Nullarbor Plain, north of Eucla, nearly two years ago, I endeavored to obtain the services of a good blackfellow, who, in the event of further traces being found, would prove a valuable aid in tracking. I was surprised to find, however, that the natives, who generally are so willing to accompany any party, or even go extraordinary distances alone to deliver a letter, were very reluctant to face the unknown plain. The knowledge of these natives is confined to the timbered strip, 20 miles wide, along the coast; and they have a tradition of a monster serpent occupying the country beyond, which they credit with fabulous deeds of destruction, and therefore could not easily be tempted to accompany me. My wishes were most kindly met by Mr. Williams, the West Australian telegraph master, who placed at my disposal his native servant, a Champion Bay blackfellow, and as "Billy" is very intelligent, and does not pay much regard to local traditions, I gladly accepted his services.

The Eucla telegraph office is about half a mile from the landing-place, and 6 miles on the West Australian side of the boundary between the two colonies. Both Mr. Clarke, the South Australian officer in charge, and Mr. Williams, were most kind, and rendered me valuable aid.

Mounting "Billy" on a lightly-packed camel, and with riding camels for myself and one man, and another pack camel to carry thirty gallons of water, I left on Saturday the 10th April, taking a northerly course, passing Moopina sheep station (Muir's) at $2\frac{1}{2}$ miles, to Nullawadda Rockhole at 11 miles. From the sandhills to the foot of the cliffs near Moopina there is a saltbush plain extending westward as far as the eye can reach. A trial well, 70ft. deep, at this station passes through consolidated sand—chiefly comminuted shells—to saltwater at sea-level.

The only water obtainable for stock is at the shallow wells in the coast sandhills, where the supply is limited.

The cliffs rise from the plain about 170ft., making the top 250ft. above the sea-level, and are the continuation of the coast cliffs sweeping inland from Wilson's Bluff, and forming the southern escarpment of the extensive marine tertiary of Nullarbor Plain. Numerous short gullies with water channels are worn in the face of the cliff, exposing good sections of the rocks, which consist of white and grey crystalline limestone over yellow friable limestone in regular horizontal stratification, both containing marine fossils. The country continues to rise quickly from the top of the cliffs, and is thickly timbered with mallee, teatree, and sandalwood. At Nullawadda it opens out into fairly grassed plains, with a good depth of red friable loamy soil. Two trial wells here by the West Australian lessee have been left unfinished, at depths of 22ft. and 31ft. respectively, both in very hard grey crystalline limestone with fossils.

Turning a little to the eastward along Fairie and Woolley's wagon track, I followed it for several miles, and camped in open sandalwood fairly grassed. A good number of kangaroos, wallabies, and other small marsupials, as well as wild dogs, and in some places wombats, are found in the timber, but the larger marsupials do not appear to have ever extended far beyond it.

Continued the next morning along wagon track about north by east. At $8\frac{3}{4}$ miles passed a small iron tank, left by Fairie and Woolley with water, but now empty. Crossed the boundary into South Australia at 12 miles.

The first few miles was very slightly undulating, with a fair depth of light red loamy soil, a few scattered sandalwood and mulga, acacia, and other bushes, for most part fairly grassed (green and dry), a little blue and salt bush on lowest parts.

The appearance of the country gradually changed about the boundary; the trees became less frequent, and the ground thickly covered with a fair growth of salt and blue bush and shrubs; very little dry grass. For most part shallow soil with limestone nodules over grey to pink crystalline limestone, which, in many places, is showing bare on surface. The slight rises are thickly covered with broomlike eremophila about 4ft. high, and in the hollows there are occasional small bare patches with samphire and mesembryanthemum. Camped at $19\frac{1}{2}$ miles.

Monday, 12th April.—Started at 7·30, continuing northerly along wagon track. At 4 miles second iron tank left by Fairie and Woolley with water, but now empty. For most part shallow soil, with a fair growth of salt and blue bush about 18in. to 20ft. high, patches of tufty grass generally very dry, but growing green in parts burnt by Fairie and Woolley. In places considerable extent of crystalline rock showing, which is sometimes fractured into large blocks; pipe-like openings to small caves seem frequent. Camped at $21\frac{3}{4}$ miles.

Tuesday, 13th April.—Continued northerly along wagon track, passing the third tank left by Fairie and Woolley, but now empty. Rather shallow light red loamy soil, the surface strewn with very small angular fragments of limestone, grey crystalline limestone showing in places fairly clothed with blue and salt bush and scattered roots of dry grass. At $17\frac{1}{2}$ miles, blowhole, 8ft. deep, with very strong wind escaping with audible

audible noise like rushing water. The wind comes from small east and west passages at bottom of hole. The formation is very hard crystalline limestone. Reached Fairie and Woolley's wagon, and camped. Distance, 21½ miles.

There must have been a considerable rainfall over the last few miles and surrounding country, as the saltbush is in bloom and good healthy growth, and all the low flats are well covered with good green herbage and a little grass. Occasionally on very slight rises the top of crystalline limestone is splintered off, and the blocks, with sharp edges, lie highly inclined in different directions.

Wednesday, 14th April.—Very strong westerly wind, with heavy banks of cloud passing over, and every prospect of rain with a falling barometer. Our hopes were, however, disappointed.

The wagon is at the northern extremity of the track and contains a small iron tank (dry now, but no doubt left with water), also harness, and numerous articles and stores. It was evidently left by Fairie and Woolley as a depôt, they, with the blackboy proceeding on horseback to examine the country for 20miles northward. It stands on a slight rise from which an extensive view is obtained. It was no doubt thought that so large an object would be most readily seen, but unfortunately that broomlike eremophila and shrubs at this spot are a little higher than usual, so that unless the precise spot is known, it is no easy matter to find it. These poor men evidently left the wagon on the 9th November, 1878, on a course of about 5°, and proceeded about 20 miles where they camped, leaving two pack-saddles, and noting in their journal (which was found by Mr. Muir) "that the water-bags were leaking." On the 10th they started to return by a slight detour eastward, and are supposed to have camped at about twenty miles, probably using their last water that night. On the next day they seemed to have turned westward, no doubt expecting to cut near the wagon. It is apparent they trusted almost entirely to their bushmanship, and although they had compasses, they could not have plotted their course, for not only did they under estimate what their south-east course should have been, and thus passed 3 miles north of the wagon, crossing their horse tracks on a very stony slope where it was almost impossible to see them, but they also overshot these tracks by 4¾ miles, and camped at a very conspicuous isolated tree (*Pittosporum*). Thus on the night of the 11th November they camped, no doubt without water, about 5½ miles N.W. by W. of their depôt. Those few days, so full of fearful import to these poor men, were the hottest of the year, the thermometer at Eucla registering 160° to 170° in the sun. This camp was found by Mr. Muir, who followed up the horse tracks on the 3rd December, 1878—about three weeks after they were made. There was found here almost everthing the lost party had with them, including riding and pack-saddles, waterbags, clothing, stores, compass, gun, and diary. A revolver and compass being the only known articles undiscovered. Anything further as to their movements can only be conjectured. Mr. Muir traced the tracks of the horses for a considerable distance towards the coast, and a few miles south of the last known camp the tracks of one man and blackboy were seen, evidently following the horses. These were soon lost sight of, and could not be traced. One horse reached Eucla, but no further trace of the others has been found, except, perhaps, the remains of a horse found by the natives on the sea cliffs may have been one. It seems most likely that one man remained at the camp during the heat of the next day, for a blanket was found stretched through the branches of the tree, evidently as a shade from the burning sun. Although Mr. Muir was on the spot so soon after the party were lost, and had the aid of camels and a native tracker, he failed to find the slightest further trace; so that there now (eighteen months afterwards) exists exceedingly little to guide further search, and the only hope of finding the remains is to come upon them entirely by chance. This very forcibly impressed itself upon me as I stood at their last-known camp and looked in the direction most likely followed. The slightly undulating surface is thickly clothed with salt, blue, and other bushes, about 2ft. high; and on the rises there is generally a small clump of larger bushes and shrubs, which in the distance show up very conspicuously, like large trees, or other large objects, and not unlike the wagon depôt, for which they might easily be mistaken, particularly in the delusive mirage of a hot day. To me it seems more than probable that these poor men, under the pressure of great suffering, abandoned anything like a systematic course, and hurried southward from one likely-looking object to another, only to meet again and again with bitter disappointment. The sad end would thus soon come.

Under this impression, I devoted two days to a careful, but fruitless search; first going about 5 miles westward, and then curving to the country southward, and minutely examining from one high bush to another, blackfellow Billy going on foot, on the alert for the slightest clue.

In the absence of the slightest trace, and the consequent uncertainty, I most reluctantly discontinued the search. I was almost compelled to do this, as I desired to reach the north side of the plain, and had only sufficient water for our absolute necessity, with every prospect of the camels having to go without for above a fortnight. I, therefore, returned to the wagon on Thursday evening, 15th April.

I have omitted to mention that numerous circular hollows, from ten to twenty acres in extent, and about 20ft. below the general level, were found 5 miles westerly of "Last Camp," in which are growing small trees about 10ft. high, chiefly a variety of mulga and pittosporum. The depression is so local that even the tops of these trees are only to be seen on approaching within a quarter of a mile of the flat. It is worthy of remark that sap water similar to the well-known mallee-root water is to be obtained from the rootlets of this variety of mulga. It simply requires the smaller roots to be taken up quickly and broken into short lengths and allowed to drain into some vessel, a clear, white, rather woody-tasted water being obtained. A pint may sometimes be collected in this way in a few minutes.

Friday, 16th April.—Started from wagon on course 340°, passing several considerable flats with green herbage and grass. Country generally slightly undulating, well clothed with salt, blue, and other bushes, in bloom and very healthy. At 8 miles very defined N.E. and S.W. valley, 30ft. deep, excellent saltbush and herbage, fair depth of red loamy soil, with underlying crystalline limestone conformable to surface. The small circular hollows, with trees, become very numerous. Camped at small flat with excellent green herbage and grass; distance, 22½ miles. The country for last few miles more decidedly undulating, but very irregular, the valleys, perhaps, for the most part have their greatest length N.E. and S.W., but are invariably broken by cross ridges. The largest tree yet seen is a mulga at this camp, 20ft. high and 1ft. in diameter. This I marked "J. W. J., latitude 30° 17′ 55″, longtitude 129° 5′."

Saturday, 17th April.—Turning more to the westward, to course 310°, the herbage and bushes continued to improve, and very fair green grass became general; the circular hollows numerous, say a quarter of a mile apart, and shallower, so that the trees are to be seen at a considerable distance, giving the country the appearance of being fairly timbered. The soil on these flats is about 2ft. of rich red loam, with almost solid crystalline limestone under, the grass and herbage very luxuriant. At 11 miles saw first kangaroos. Camped at 16¾ miles, on edge of thick timber. Started

Started on foot westerly. At 1½ miles low north and south ridges commence, thickly timbered with mulga, sandalwood, myall, black oak, and large bushes and shrubs, the valleys fairly grassed, with a little salt and blue bush. At four miles, larger timber and succession of low ridges, friable loamy soil, parts sandy, with limestone nodules, about 2ft. in depth, over dark grey to pink crystalline limestone, with stratification conformable to surface. Returned to camp by a detour northwards. Kangaroos, turkeys, and a variety of small birds very numerous. Very fine tufty grass and herbage on flats, including geranium and other good herbs, many in bloom.

There can, I think, be no doubt that this is the northern side of Nullarbor Plain, and is a point of the timbered country sweeping southward from Giles' track, near Boundary Dam. Marked large mallee "J.W.J. Lat. 30° 9′ 43″, long. 128° 53′ E.," from which it will be seen that I was several miles in Western Australia. Having satisfied myself of this being the north side of the plain, and almost the same description of country passed through by Mr. Ernest Giles, a little further northwards, I decided to turn eastward. The camels had now been eight days without water, and the weather very hot, the thermometer day after day reaching nearly 100° in the shade.

Started at dawn the next morning and passed through almost level country, thickly clothed with salt and blue bush and shrubs, little green tufty grass, and herbs. Small circular hollows, with trees, about a mile apart. At 14¼ miles decided undulations commence, several valleys 60ft. deep; fair depth of soil in bottom, but very shallow on slopes. Underlying crystalline limestone, conforming to contour of surface, in places were showing, fractured into large cubes by cracks an inch or two wide. Camped at 20 miles. Thermometer, 94° in the shade.

Monday, 19*th April*.—Continued easterly. The small flats with trees became less frequent, and shrubs and herbs not so good, and considerable extent of broomlike eremophila, which invariably marks the worst parts of this country. Little salt and blue bush, and in places a little almost dry tufty grass. Camped at 21 miles. The country north of this camp, which I examined for several miles, and could see on to a very distant horizon, is generally level with red loamy soil, from six inches to a foot in depth; the surface strewn with angular fragments of limestone, the underlying rock very hard, grey to pink crystalline limestone with fossils, numerous small pipes, cavities, and fissures, making it very porous to water.

Tuesday, 20*th April*.—Every appearance of rain during the night, but none fell near us. I think there were light showers northward.

Turned almost southward, to course 170°. The same description of country continuing, the small flats with trees became more distant, and ceased at 18 miles. Camped at 25 miles.

Wednesday, 21*st April*.—Continued on course 170°. Rather scanty salt and blue bush and few shrubs, scattered roots of dry tufty grass. At 3¾ miles extensive east and west valleys 45ft. below general level. Deep red loamy soil thickly clothed with salt and cotton bush. At 10¾ miles another extensive east and west valley several miles long, with fair shrubs, herbage and a little green grass; a good depth of rich red loamy soil. Occasional small clumps of eremophila on rises, looking in the distance like large trees, and it is only after repeated disappointments that the thought is given up of finding them to be such. At 22½ miles pipe-like cavity, 10ft. deep, in reddish highly crystalline limestone. Camped at 4·15. Distance, 25 miles.

Thursday, 22*nd April*.—Very copious dew during the night; allowed the camels to stay a little longer than usual on the wet herbage. Changed course to 190°. At 3½ miles shallow cave, and at 6¼ miles another pipe-like cavity. The country generally nearly level, fairly clothed with salt and blue bush and shrubs, scattered tufts of dry grass for most part not grown for a year or two, a very little now springing green. A fair depth of red loamy soil. Some very small flats with samphire and mesembryanthemum. At 17½ miles cave 12ft. deep with north and south passages. There are several small waterworn channels leading to the mouth of this cave, which is the case more or less with many of these cavities. At 22¾ miles another cave 30ft. deep, a strong current of wind escaping from small passages. Camped at 4·40 p.m. Distance, 24 miles.

Friday, 23*rd April*.—Changed course to 220°. For most part red loamy soil, 12in. to 18in. deep, over fine-grained white and grey crystalline limestone, fairly clothed with salt and blue bush and a few low shrubs, very little dry tufty grass. At 4½ miles considerable north and south valley, half a mile wide at bottom, 25ft. to 30ft. below general level. Considerable extent of samphire in bottom of valley, rather scanty saltbush shrubs and eremophila on slopes. A small clump of mulga in sight about a mile south.

At 16 miles scattered clumps of mulga and sandalwood, a few shrubs, and thick growth of eremophila, blue and salt bush. At 20 miles edge of fairly timbered country, and at one mile further crossed Delisser's surveyed line at twenty-second mile-post. Reached track at 23½ miles, turned along it westerly, and camped at 5.50 p.m. Distance, 29 miles.

Saturday, 24*th April*.—Started at dawn along track westerly and took branch track to Bunburra Rock-hole, which is a circular well-shaped cavity in crystalline limestone, 5ft. diameter, and 9ft. deep. Since entering the timbered country the surface soil has been a light red friable loam, with nodules of recent limestone, and averages from 1ft. to 3ft. in depth. The timber is small and scattered, and consists chiefly of sandalwood, mulga, and a little myall and quondong. For the most part there is a thick underbrush of bushes and shrubs. Considerable flats occur with a little saltbush, herbs, and very good tufty grass, 18in. high. This strip of country may be said to be well grassed. Continued along the track *viâ* Nullawadda to Eucla, and arrived at 6 p.m. Distance, 31 miles.

The record of this trip may be thus summarised:—

In 15 days travelled 340 miles, which, except known rockholes near the coast, was found to be entirely waterless, the camels were, therefore, without for the whole time, and appeared but very little distressed in consequence.

The formation throughout was found to be grey to pink crystalline limestone, with stratification conformable to surface, marine fossils on or near surface in many places.

Numerous pipe-like cavities and small caves to 30ft. deep.

The cliffs directly north of Eucla are 250ft. above sea-level, and the table land continues to rise, attaining 300ft. at 3 miles, and thence gradually rising to 600ft. at 110 miles.

About the meridian of return track (32 miles within South Australia) the cliffs rise about 230ft. perpendicular from the sea, and the table land rises therefrom about 2½ft. in a mile for 20 miles, and then nearly 5ft. in a mile, attaining about 650ft. above sea-level at 100 miles.

A strip of country along the coast averaging about 17 miles wide is fairly timbered with rather dwarf trees, and fairly clothed with shrubs, herbage, and good grass. Nullarbor

Nullarbor Plain is for most part gently and in some places decidedly undulating, some of the valleys 50ft. to 75ft. below general level. The central part of plain is entirely treeless, but thickly clothed with low shrubs and herbs, and very little grass.

The northern side of the plain has very numerous small circular hollows, with trees and excellent green herbage and grass.

The entire area examined is fairly to well suited for sheep depasturing if water obtainable.

Second Trip.

Having received instructions by wire from the Surveyor-General to extend the examination of Nullarbor Plain, I left Eucla on Thursday, 6th May, my party consisting of two men, with three riding, and two pack camels. Followed the telegraph road easterly, and camped on table land, near province boundary, with the view of tracing out Delisser's surveyed line. The country here, from the top of cliffs, is thickly timbered with dwarf mallee, teatree, and large bushes, and is for most part very poor country.

Friday, 7th May.—Started at daylight eastward along telegraph. At 7 miles much improved herbage and considerable flats, with good tufty grass, and fair salt and blue bush; lightly timbered with sandalwood and mulga. Camped at Coompana tank. Distance, 26 miles.

Saturday, 8th May.—Started at sunrise on course 40°, leaving the telegraph line on my right, and passed through very well grassed lightly-timbered country, tufts of excellent green grass growing amidst the tall dry growth of last year. At 5 miles left timber and re-entered Nullarbor Plain, slightly undulating, with rather scanty salt, blue, and cotton bush shrubs, and broomlike eremophila, very little dry tufty grass, fair depth of friable loamy soil, with limestone nodules over compact crystalline limestone. Camped at 2·38 p.m. Distance, 26¼ miles.

Sunday, 9th May.—Started at daylight on course 40°. At 6 miles, small flats, with red loamy soil surrounded by samphire, the higher land growing salt and blue bush and eremophila, crystalline limestone cropping out irregularly. At 11¾ miles, pipe-like cavity, 6ft. deep, in grey crystalline limestone. At 17 miles, another cavity 10ft. deep, with strong wind escaping from north and south passages. Camped at 2·42 p.m. Distance, 25¾ miles.

Monday, 10th May.—Changed course to 10°. Slightly undulating, about a foot of red loamy soil over compact grey crystalline limestone with fossils. In places small angular fragments of stone strewn over surface of ground. For most part lightly clothed with salt and blue bush in about equal proportions, and a little broom and shrubs; a very few tufts of old dry grass. At 1⅓ miles blowhole 15ft. deep, with north and south passages at bottom. At 5½ miles considerable east and west ridge. At 22⅓ miles considerable valley; herbage and shrubs better in bottom of valley. Camped at 25⅓ miles.

Tuesday, 11th May.—Continued on course 10°. Started at 6·14 a.m. At 6½ miles hollow, with small trees and bushes. Rather poor open salt and blue bush. At 19 miles numerous small hollows, with small mulga, and fair herbage. The bushes and herbage much improved, and there is a little coarse grass growing green. Traces of kangaroos.

Camped at small mulga flat; distance 26½ miles. A little dry tufty grass of recent growth on rises. Some of the trees in this flat have been burnt many years ago, no doubt by natives on hunting excursions, as there are numerous old traces of kangaroos. The soil in these flats is a rich red loam, about 2ft. deep, over crystalline limestone. A few small flints were found on surface. Dingoes very numerous at night.

Wednesday, 12th May.—Made a very early start, continuing on course 10°. Hollows with trees became numerous. At 8½ miles decidedly undulating; scattered bushes of mulga and grevillea; shrubs and herbage poor. At 11 miles the bushes became larger and very dense; a few scattered sandalwood. Numerous small flats with good fresh green herbage, geranium, mallow, and fair grass; kangaroos numerous.

This country is, in most respects, very similar to that seen by me on the previous trip, in latitude 30° 9′ 43″ S., longitude 128° 53′ E. At 12½ miles, northern side of Nullarbor Plain, large timber commences, sandalwood, myall, mulga, quondong, mallee, a few scattered black oaks, and very dense large mulga bushes. The soil for most part friable loam with limestone nodules, but with frequent low ridges of red sand. At 20 miles mark of recent fire in large bushes, evidently a signal fire by travelling aborigines. Other camping places of natives were met with, at which small bundles of mallee rootlets were lying about, showing that the root water had been used, and was probably the only water obtainable.

Camped at 23¼ miles, latitude 29° 52′ 45″ S. The country here, as far as can be seen northward or westward, is almost level, with occasional very low rises of dark red sand. The surface soil is a reddish friable loam with small rounded nodules of recent limestone, and averages about 6ft. deep. The underlying rock is a very hard dark grey crystalline limestone. Densely timbered with trees and bushes. Some small flats growing good green herbage and grass. There can be no doubt that this description of country continues to Giles' track, a few miles further north.

Thursday, 13th May.—I quite expected to find high sandhills forming the northern side of the plain here, as the Ooldea Hills were supposed to continue throughout. Thinking to find their termination, I turned to 120°, through almost level country very thickly timbered with mulga, black oak, mallee, &c. At 5 miles the end of a considerable sand ridge. At 8 miles very high east and west sandhills, growing spinifex and dwarf mallee. Very large timber in valleys, chiefly black oak. This is evidently the western limit of Ooldea Hills. They here trend inland in a N.N.W. direction. At 10 miles changed to 160°, over succession of loose red sandhills 50ft. high, and very steep. At 3¾ miles the sandhills give place to level country thickly timbered with mallee, mulga, and sandalwood, an occasional small flat with very good green herbage and grass, and Sturt pea *(clianthus dampierii)* in bloom. Camped at 4·12 p.m. Distance, 22 miles.

Friday, 14th May.—Continued on course 160°. At half a mile edge of timber, scattered mulga bushes and a little rather poor salt and blue bush. Shallow soil over crystalline limestone with fossils. At 19 miles much improved shrubs and herbage. Camped at low flat with good green herbage. Distance, 20 miles.

Saturday, 15th May.—Continued the same course through the same description of country. At 18 miles changed to *south*. Camped at 23½ miles.

Sunday, 16th May.—As this was the eleventh day the camels had been without water, I decided to push on southward. Very little change in country; some parts a little more undulating than others. Several blowholes in crystalline limestone. Camped at 24 miles. A light shower of rain during the night.

Monday,

Monday, 17*th May*.—Continued southward. At 3 miles reached Delisser's Kudna Rockhole, and although there was only about fifteen gallons of water, it was most acceptable both to ourselves and the camels. Our own supply in the casks was reduced to the last quart-potful. Remained and erected a pile of white limestone 9ft. high, which may be seen for a considerable distance, and may assist others to find the water. The storing capacity is very small, at most fifty gallons. A very beaten dingoes' pad leads to the water from the westward. Generally level country, with fair to good growth of blue, salt and cotton bush, and little broom on rises. No grass worth mentioning. The mean of several good observations gave the latitude 31° 6′ 10″ S.

Tuesday, 18*th May*.—Very dense fog in early morning, and copious moisture. Started at daylight still southward. At seventy chains cave in crystalline limestone 100ft. deep, with large chambers extending several hundred feet east and west. After passing down the small pipe-like entrance, and through the first chamber, the darkness becomes intense, and it was only by the aid of candles and fire sticks that I continued further examination. I only saw a comparatively small part of these immense caves, as passages and chambers innumerable seemed to turn off in all directions. My barometer gave the depth 100ft. at the bottom of a long declining passage. In my scramblings towards daylight I had the misfortune to give my barometer a knock, which so deranged it as to render it unreliable. At 10 miles a very small rockhole with perhaps a gallon of water. Fair growth of salt, blue and cotton bush. Broomlike eremophila and shrubs on slight rises. A few scattered trees indicate the approach to timbered country, which was reached at 16 miles. Sandalwood, mulga, quondong, bushes, shrubs, and a little fair grass. At 25 miles Eucla telegraph line near Delisser's eighteenth mile-post. Turned easterly to Mallabie tank and camped. Distance, 27¾ miles.

Continued easterly along the telegraph line the next morning, and on the following day reached the Bight substation. The sea cliffs terminate abruptly at the extreme head of the Great Australian Bight, about 2 miles south-west of the station. Inland at the telegraph, the ground slopes rapidly for a few miles to the foot of very high white sand dunes. The drainage from these sandhills gives a fair supply of slightly brackish water in several shallow wells. In a well at Government Camp, near the sea, the water is perfectly fresh. The well at the station is 12ft. deep, in consolidated sand, and bottomed in clay. The supply has warranted the erection of a windmill, tank, and troughs.

Friday, 21*st May*.—Returned along the telegraph to Roberts' Well, passing a salt well 14 miles from the Bight. This well I found to be 160ft. deep, at which depth salt water was struck, and the well abandoned. The spoil heap shows white and grey crystalline limestone, yellow friable limestone, and soft white chalky limestone with flints and fossils. Roberts' Well is 174ft. 6in. deep, and is down to salt water. The spoil shows similar formation, with very numerous marine fossils. Gray's Well, about three-quarters of a mile south, is only 24ft. deep, in hard crystalline limestone, at which depth it was abandoned.

Saturday.—Turned northward along track to another well at 4 miles. This is the third trial well sunk for Mr. Price Maurice. It was left unfinished at 147ft. The spoil heap shows similar formation to the others, perhaps a little softer white crystalline limestone over reddish friable limestone, and bottomed in white chalky limestone with flints. Very numerous fossils in each stratum. Continued northwards. At half a mile edge of timber; at 2½ miles two immense caves, the native name of which I ascertained to be Murrawijinee. The entrances are large irregular openings formed by the falling away of the surface crust; declining passages were traced to a depth of 90ft. One chamber is 200ft. by 130ft., and 15ft. to 25ft. high. Small stalactites, and a considerable stalagmatic deposit exist, and there is an immense deposit of bones of birds and animals, evidently existing species. The dingoes take up their abode in most of these caves, where the entrance is accessible to them. The formation is the same as the last well. Went on 4 miles and camped on plain. Decidedly undulating N.E. and S.W. ridges; a fair depth of soil, thickly clothed with eremophila, blue and salt bush, and shrubs.

Sunday.—Turned west. Similar country. Very dry. Camped at 21 miles.

Monday.—Continued west for 19 miles, and then changed to 140° towards the telegraph line. Rather scanty salt and blue bush, and considerable extent of broomlike eremophila. A little very scattered dry tufty grass. Small flats, with samphire and mesembryanthemum. Camped on edge of timber. Distance, 24 miles.

Tuesday, 25*th*.—Continued to telegraph line at Delisser's sixty-third mile-post. A considerable extent of well grassed flats. Blowhole near telegraph 35ft. deep. Camped at 26 miles.

Wednesday.—Continued west along telegraph line to Albala-Karoo blowhole. Measurements with a line proved the depth to be 72ft. to the loose *debris* in bottom. The formation seems identical with the sea cliffs, the top being a white very hard crystalline limestone with dark highly crystalline bands, and the bottom white chalky limestone.

This is the site subsequently recommended by me, and approved by the Surveyor-General, for the first trial borings. The country immediately surrounding is slightly undulating and fairly timbered. Good salt-bush and shrubs, and excellent tufty grass. Pushed on and reached Mr. Thomiar's camp at Bunburra about 9 p.m. Distance, 36 miles

The following is a brief summary of this trip:—

In twenty-one days travelled 460 miles.

The crystalline limestone formation continues throughout the entire area examined.

There are numerous blowholes and very large caves.

With the exception of one or two small rockholes near the coast timber, no water was found, the camels going without for twelve days.

The plain for the most part is fairly to well clothed with salt, blue, and cotton bush, shrubs, and herbs.

The northern side of the plain was reached at 106 miles from the coast. There were evident signs of a greater rainfall. Excellent green herbage and grass.

The Ooldea sandhills were found to curve inland towards the large salt lake discovered by Giles.

The plain was found to rise about 1⅓ft. in a mile, the north side being 450ft. above sea-level, the timbered country northwards to Giles' track appearing nearly level.

Several deep trial wells were examined west of the Bight. Water salt, and formation identical with cliffs.

A natural hole, 70ft. deep, near the telegraph line, 44 miles E.N.E. of Eucla, and named Albala-Karoo, was examined, and subsequently recommended as the site for first trial borings.

The advantages of this site are almost a natural well-shaft, through the very hard crystalline limestone, for 72ft., with a fair prospect of cutting brackish or salt water at a moderate depth below the bottom of hole; this is required to work the machine for the deeper drilling. Another advantage is being surrounded by timber suitable for fuel for the engine. The surface falls towards the sea cliffs about 4ft. in a mile, the cliffs immediately south being 252ft. high, and the well-site, therefore, 294ft. above sea level.

The country surrounding the site is very good, and capable of carrying a large percentage of stock if water is found. Until this is done it must remain unstocked, as the nearest water is Merdeyarrah sand-patch, 33 miles south-westerly.

Third Trip over Nullarbor Plain to Ooldea.

Having seen Mr. Thomiar commence work at Albala-Karoo, the site recommended by me and approved for the first trial well, I started on Thursday, 15th July, with one man and four camels, to examine the eastern part of the great plain.

Followed the telegraph line eastward to Guinewarra tank, and then turned off north-easterly for Knardna Rockhole, which I found to be one of the common pipes in the crystalline limestone, 10ft. deep, evidently without the usual fissures and air passages. The storm water is collected from a small surface area of rock. The hole is capable of containing 800 gallons, but was only a quarter full.

Thence took a northerly course for 3½ miles, and camped at edge of timber. During the evening several light showers of rain passed over in an inland direction.

On Saturday, 17th July, entered the plain on a course magnetic north. Surface slightly undulating, fairly clothed with salt and blue bush, a few shrubs, and broomlike eremophila; in places a little scattered dry tufty grass. Some of the soil very shallow.

At 15 miles passed the furthest point reached by Professor Tate. Generally slightly undulating, open salt and blue bush; parts very shallow soil, with crystalline limestone exposed. An occasional flat of red loamy soil growing samphire and mesembryanthemum. Continued northwards; the shrubs and herbage gradually improved. At 4 miles a thick growth of healthy salt and other bushes, and very good green herbage and grass became general, and, although the rock continued to show in places, there was for the most part a good depth of light loamy soil.

At 25 miles, latitude 30° 59′ 20″ S., changed course to 59° east of north, the excellent shrubs and green herbage and grass continuing. At half a mile blowhole 20ft deep, with several other holes and small caves near.

At 10 miles the green herbage not quite so good, and gradually become more scanty with parts rather dry, and considerable extent of stony surface. At 36 miles blowhole in light grey crystalline limestone, 20ft. deep, with strong wind escaping; several other similar holes in vicinity. Evident signs of a considerable local rainfall. Excellent green herbage, grass and bushes, gently undulating, for most part a fair depth of light loamy soil with white and grey crystalline limestone showing in some places. At 54 miles very much drier, very little herbage, scanty salt and blue bush, grey crystalline limestone continuing to show through rather shallow loamy soil.

Camped on Tuesday evening at 65 miles, and obtained the first sight of Ooldea Range lying about 26 miles to the northwards. As the range was approached, small flats with mulga bushes and black oak became general. Passed several very decided terraces 30ft. to 50ft. high, falling eastward like old sea cliffs. These extend southward on the plain as far as the eye can reach. The formation is horizontal crystalline limestone. The plain for some distance falls towards the foot of each of these cliffs, but there is a general fall of the country eastward towards Ooldea.

At 79 miles passed Mr. Cornish's surveyed line near the twenty-fourth mile-post, and camped six miles further on at edge of low sandhills thickly timbered with mulga, sandalwood, and black oak. These low sand ridges are composed of reddish siliceous sand, overlying a loamy soil with nodular limestone which shows in valleys. They trend nearly east and west, and occupy a width of about six miles at the foot of a very conspicuous and defined black range. Numerous small flats on edge of timber with good green herbage and little grass. Very luxuriant Sturt pea *(clianthus dampierii)* in bloom. A little fair dry and green grass in timber.

After spending a day in examining the surrounding country we reached Ooldea water on Friday 23rd July.

The water here is simply rainwater absorbed by a ring of sandhills 50ft. high, resting on a bed of red and blue clay. The level bottom of central basin has an area of ten acres, lightly covered with sand. In small wells, at a depth of 3ft., a fair supply of excellent water is obtained. The central ring of high hills is succeeded by other lower ridges for a radius of a mile and a half. This makes the water almost inaccessible for vehicles. Outside this circle the east and west ridges are very much lower, and on the north side almost entirely absent.

Thinking it desirable to visit some wells recently sunk by Mr. Tietkins, I followed his dray track northwards. At 11 miles reached the top of Ooldea Range, about 650ft. above sea-level, and 400ft. above Nullarbor Plain, immediately to the south. This range is very defined on the south side, but broken into spurs and hollows on the north. The soil for the most part is loamy, with nodular limestone, coated in some places by red siliceous sand. The hills are lightly, and the valleys and hollows thickly, timbered with dwarf mallee, myall, mulga, sandalwood, and a few pines. At 22 miles left the last spur of range and entered slightly undulating country, fairly timbered; a little dry grass. At 33 miles reached Mr. Tietkins' wells, in an extensive east and west valley.

I was unable to go down the wells as the workmen had removed their appliances and left the place, but I collected complete specimens from the spoil heaps, and subsequently obtained from Mr. Tietkins the details given in following section:—

	ft.	in.
Soil and nodular limestone	1	0
Hard calcareous puddingstone	7	0
Softer limestone	20	0
Hard fine grained calcareous sandstone	12	0
Yellow quartzose sand	10	0
Brown calcareous sandstone	10	0
Porous yellow sandstone	30	0
Iron band	0	1
Black sand	6	0
White micaceous clay, with lumps of inundic	20	0
Total depth	116	1

A small supply of water was struck in the black sand, and it is stated to have been almost fresh; but on deepening the well into the white micaceous clay the supply was increased, but the water became very brackish.

The country immediately surrounding the wells is open and slightly undulating, with a fair depth of friable loamy soil, growing salt and blue bush, shrubs, and a little grass.

Returned to Ooldea on Tuesday, 27th, and remained two days to record readings of aneroid for the determination of height above sea-level by comparison with simultaneous observations at Fowler's Bay. The result made the plain at Ooldea and this part of Nullarbor Plain 250ft. above sea-level.

On my return along the Pedinga track I examined the wells sunk on the edge of Nullarbor Plain, near Ooldea, by Mr. Crawford. Judging from the spoil heap, I give the following very approximate section:—

	ft.	in.
Friable loamy soil		
Nodular limestone	5	0
White to pink fossiliferous crystalline limestone	20	0
Yellow limestone, with quartz grains	35	0
Yellow quartzose sand	10	0
	10	0
Total depth to salt water	80	0

The metamorphic rocks of Pedinga rise to a height of 40ft. above the level of swamp. The well-known rockholes forming "Pedinga water" are large basin-shaped cavities, 8ft. deep, in immense blocks of gneiss. These rocks are lying irregularly almost perpendicular. The average strike here is about 22° east of north, but further south, along the edge of swamp, it curves to 60° east of north.

After examining the wells sunk by Mr. Matthews, records of which are in the office, and also the numerous wells easterly from Colona, I arrived at Fowler's Bay on Wednesday, 4th August.

So far as I could learn, the whole of the wells from Tallowan to Fowler's Bay are bottomed in quartzose sand, or clay. Some are nearly fresh, and others very brackish. Many are capable of watering from five to six thousand sheep. A considerable number of other wells were sunk amidst these, and found to be quite salt.

I have omitted to say, with reference to the very numerous and somewhat remarkable "blowholes" in the limestone formation, that there were many similar cavities without the escape of air. I think invariably this "blowing" only occurs when there are other large cavities in the immediate locality, and that the force and direction of the wind has an important influence. At several holes I was able to satisfy myself that one day, with the wind in a certain direction, there was a strong current of air escaping sufficient to blow back even flat stones thrown into the mouth of the hole, and on the next day, with a change of wind, the air was passing downwards into the hole. These cavities are from 10ft. to 100ft., and 1ft. to 10ft. diameter, generally in the form of a circular shaft almost vertical, with fissures and small passages at bottom.

JAMES W. JONES, Chief Surveyor.