exhaustion of the head by an uncontrolled draft is, however, irremediable; hence in the absence of a healthy public opinion on the matter, legislative enactment is the sole preventative.

2.—GRAPHITE ON THE LOWER PALLINUP RIVER.

(A. Gibb Maitland.)

A brief account of the graphite deposit of the Lower Pallinup River appeared as Article 2 in the Annual Progress Report of the Geological Survey for the year 1923. Since that article was written the following report on a sample (1/3865) collected by myself, and submitted to the Government Chemical Laboratory has been received:—

Proximate Analysis (L. 898/24).

Volatile matter	6.54
Carbon	54.72
Ash	38.74
	100.00

"The gangue is mainly kaolin. This sample is of no value as a source of flake graphite owing to the graphite being present in minute scales. It contains too much mineral matter to be of use for foundry work or pencil making, but might be used for stove polish."

3.—NOTES ON THE COUNTRY IN THE VICINITY AND TO THE NORTHWARD OF ISRAELITE BAY, EUCLA DIVISION.

(A. Gibb Maitland.)

The period between the 12th May and the 26th July was devoted to a reconnaissance of the geologically little known country between Esperance, Israelite Bay, and Fraser's Range. The country was reached by an overland journey from Ongerup *via* Ravensthorpe.

An examination of the country between Norseman and Esperance had been made prior to the present journey by travelling from Norseman via Moir's Rock and the Fitzgerald Peaks, thence down the Salt (or Lort) River to the coast. From the mouth of the Lort River the road to Esperance was followed as far as Gage Lake, into which the Dalyup River discharges its waters, thence up the river to the Norseman road as far as the Government tank at the Salmon Gums. A return to Esperance *via* the Grass Paddocks and Bostock Swamp was made. The eastern margin of the country was examined from the Old Fraser's Range Road, *via* Mount Ridley, Clear Streak Well, and Boojebeenyer. The route followed, involving about 800 miles on horseback, enabled a general idea of the geology of the whole of the Esperance hinterland to be obtained, the salient features of which have been included in these notes.

The country in the neighbourhood of Esperance Bay and the hinterland is a tableland made up mainly of granitic rocks of which that [11847] from Mount Ridley is typical. Mount Ridley (N. 24) is a very conspicuous granite ridge trending generally east and west, with a fairly bold escarpment on the northern face. The ridge is about a mile in length, and the highest point rises to a height of about 340 feet above the level of the well.

At Cowalyina (Reserve 2790), several miles to the north of Mount Ridley, the granite has given place to granitic gneiss [11848], the foliation planes of which are vertical and have a dominant strike of northwest and southeast.

The surface of the tableland is of extreme irregularity, and is occupied by a series of salt pans and lakes. These dry or salt lake basins are exceptionally numerous; they are very variable in their outline, are in some cases many miles wide, and the area of some of them is very great. These salt lakes are often very isolated, though at other times loosely strung together, being separated by narrow divisions. Their resemblance to and connection with river channels may be noted in their elongated shape, of which Lake Raeside, over 100 miles in length, may be cited as a typical example. Lake Raeside constitutes the main channel of the central group of lakes forming an ancient water course flowing into the upper reaches of the Ponton River, which is the only defined water channel of any length. The Ponton River in parts of its course is a deep channel with well-defined banks and empties into a large clay pan at a point about 40 miles from where it crosses the Trans-Continental Railway line between Zanthus and Kitchener. Its course from the clay-pan is represented by a broad ill-defined channel trending southward for about two miles, when it loses itself in a large salt-bush flat broken by low banks of powdery gypsum. The flat represents the uplifted estuary into which the Ponton flowed north of Balladonia. The estuary of the Ponton is 120 miles due north of the coast line along the Great Australian Bight.

The series of which Lakes Dundas and Cowan form part are not lakes in the ordinary sense of the word, with a well-defined basin, but are merely parts of another independent river system which had its mouth in the Miocene Sea near Norseman, and the Archipelago of the Recherche near the Lort River. In traversing the Lort (or Salt) River in August, 1911, it was then a strong deep running river of salt water, almost a brine, owing to the fairly heavy rains which had fallen in the hinterland, and was carrying off the overflow from the lakes. A similar condition of affairs was noticed in 1919 by my colleague, Mr. Talbot, when traversing the Ponton; at that time, after a rainfall of two and a half inches, the upper reaches of the river were running very strongly with salt water derived from the salt lakes which form the upper portion of its course.

The existence of such river systems points to the fact that this portion of Western Australia had a heavier rainfall and was much better watered than it is at present, and implies a comparatively recent desiccation of the country which resulted from a regional uplift of about 1,000 feet. Such an uplift tends to cause the rainfall to become heavier on the coastal areas and lighter in the interior. The increase of rainfall in the coastal areas tends to hasten the lowering of their level by denudation and the cutting back of their channels, with ultimately the restoration of a more even distribution of the rain.

Many of the salt lakes contain gypsum deposits. The large lake to the east of Stennet's Rock (Reserve 3045)* has along its edge a deposit about 12 inches in thickness of small crystals of gypsum, whilst near the centre of the lake they are of larger size, often over an inch in length. The crystals in the centre of the lake are not perfectly formed, whilst those along the banks have as a rule all their edges rounded as a result of wind erosion.

Along the shores of some of the lakes horizontal beds of gritty ferruginous sandstone are met with.

*Lands and Surveys Department, Lithograph 11/300.

These sandstones are nowhere very thick. In other localities outliers of quasivitreous quartzites occur and testify to the former wide extension of sedimentary rocks in this portion of the State.

With the exception of a *Pecten* (?) [1/3916] obtained by Mr. C. Hancock from the Oil Prospecting Area 154H, no fossils have yet been met with in the more immediate vicinity of Esperance.

These thin sediments are in all probability only the remnants left in the Plantagenet (Miocene) Beds which are met with at intervals along the maritime districts of the southern portion of the State. Remnants of an extensive limestone deposit of Miocene age occur at Norseman at an altitude of 900 feet above sea level and about 100 miles distant from the coast, and which forms part of the same series.

There is in addition a soft white siliceous rock made up almost entirely of the spicular remains of siliceous sponges. Representatives of these sponge beds have also been met with on the northern shores of Lake Cowan. The deposit consists of a fine-grained marine silt exposed in a series of low white cliffs near the head of Lake Cowan, about 35 miles above Norseman, thus furnishing an indication of the wide area over which these Miocene beds at one time extended.

Cape Paisley Mica Deposit.—A very coarse grained pegmatite [1/3696] dyke, measuring 15 feet in width and of considerable horizontal extent, occurs on the seaward slope of hill No. 61* at Cape Paisley, which rises to a height of 545 feet† above sea level. The dyke occurs along the vertical foliation planes of a highly micaceous gneissic granite, which constitutes the staple formation in the vicinity of the cape, and which has a general northeast and southwest strike. The pegmatite, so far as can be seen, contains potash mica in the form of small books, from which fair quantities of scrap mica are obtainable, although from the material lying on the surface there were sheets capable of being cut into sizes averaging about 2 by 3 inches. In addition to the mica the dyke contains some large fragments of the potash felspar, microcline [1/3705], which in this locality forms an important constituent of the pegmatite and might under suitable conditions prove capable of being exploited as a source of commercial potash, for the deposit appears capable of yielding a considerable tonnage of felspar.

Other mica deposits occur in the vicinity of Cape Paisley. One is situated about three miles north of Bellinger Sand Patch. The mica occurs in pegmatite dykes as "books," from some of which sheets three by four inches could be cut. The quality proved to be excellent, and when submitted to electrical tests proved to be of very high grade.

What is shown on the maps issued by the Department of Lands and Surveys and the Admiralty charts as Mica Hill, some miles to the north of Cape Paisley, takes its name from the mineral occurring in that locality. Some of the mica from Mica Hill (?) contains inclusions of magnetite (magnetic oxide of iron).

The mica-carrying belt of this portion of the State is of considerable extent, having been noted at Simon's Hill, in the Fraser's Range, at which locality several coarse-grained pegmatite veins occur. One of these dykes, about 6 to 10 feet wide, in which "books" of mica two or three inches square occur, has been opened out to a depth of from 6 to 8 feet. Large crystals of black tourmaline occur in the dyke in addition to the mica crystals.

Mount Ragged Range.—Opportunity was taken to make a brief examination of that group of hills of which Mounts Ragged, Dean, and Russel Range constitute the most conspicuous and outstanding features. Mount Ragged (Rugged) was described by Matthew Flinders in January, 1802, as "lying N. 8° W., 9 or 10 leagues from Cape Paisley." The natives of the interior gave the name of Barninggunyah to the mountain, whilst those of the coastal tribes called it Carta-currup. It was referred to as a "jagged peak" by Mr. E. J. Eyre on the 16th May, 1841, in the journal describing his overland journey from Adelaide to King George's Sound.‡

The Russel Range, "lofty and abrupt mountain masses," which lies to the north of Mount Ragged, was named by Eyre on the 26th May, 1841, in honour of Lord John Russel, who at that time occupied the position of Secretary for State for the Colonies.

Mount Ragged, situated about twenty-five miles west-north-west of Israelite Bay, forms one of the landmarks on the dividing line between the Eastern and the Eucla land divisions. The mount forms the highest summit of a very narrow razor-backed ridge with very deep sides, alpine in its grandeur, which extends for some three miles in a direction about north 20 to 30 degrees east.

Mount Ragged is separated from Mount Russel by a well-defined valley trending generally northwest and southeast, and suggesting the possibility of its marking the trend of a fault which extends to the southeast and truncates the southwestern continuation of that range, the principal and most conspicuous summit being formed by Mount Dean. The Mount Dean Range lies to the eastward of Mount Russel and is separated from it by a longitudinal valley from three to four miles wide, and which trends generally northeast and southwest with a gradual fall to the south. No opportunity presented itself of visiting either Mounts Dean or Russel, but from what could be seen from Mount Ragged, they seem to be similar in geological constitution and structure.

The Mount Ragged Range is made up of granitic gneisses and allied schistose rocks, the foliation planes of which dip to the southeast at angles varying from 50 to 60 degrees, and have a general strike of north 20 to 30 degrees east. The mineral constituents of the schists are mainly quartz, with silvery white mica giving them a characteristic lustre, oxide of iron, and a few small zircons. The schists seem to be genetically related to plutonic igneous rocks and probably owe their origin to the transmutation of a granite as a result of the stresses and strains to which it has been subjected since consolidation.

There is a highly plicated thin micaceous band near the southern end of the range, which appears to mark a shear zone along a highly inclined thrust plane. There are numerous contorted quartz veins which conform to the folding which the laminae have undergone. The band contains some fairly large crystals of andalusite [1/3718]. The mineral was

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* Lands and Surveys Department Lithograph 3/300. † Admiralty Chart 1059 gives the height as being 345 feet.
‡ Natural Features of Israelite Bay. J. P. Brooke. Aust. Assn. Adv. Sci., Brisbane, 1895, p.p. 561–569.

examined by Dr. E. S. Simpson, who reported that "This has density of 3.22 with a mean refractive index 1.63. It is andalusite, crowded with minute inclusions chiefly carbon, but also rutile, quartz, gas, etc. Similar specimens were received from this locality in 1910, and recorded in the census published by the W.A. Museum in 1912."*

Two schistose rocks [1/3698] and [1/3699] from different portions of the Mount Ragged Range have been examined by the Acting Petrologist, Dr. Larcombe, and chemical analyses made in the Government Laboratory under the direction of Dr. Simpson.

[1/3698, S. 4515.] South end of Mount Ragged. Macroscopic features: A very fine grained granular and somewhat foliated rock with a saccharoidal appearance. It consists of grains of sand with specks of white mica, which are abundant enough to give a powerful sheen to fractures in the direction of the planes of schistosity. Microscopic features: In section the rock is made up of a more or less even granular aggregate of quartz grains averaging about 1/5 m.m. or 1/130 of an inch in diameter. The quartz grains are irregular in shape and do not show much rounding. Between the quartz grains are small rods of white mica arranged with their lengths in more or less parallel direction. The average length of the rods of mica is about 1/125 of an inch. The only other constituents in the rock are a few black specks of oxide of iron and an occasional minute prism of zircon. The rock is a quartz sericite schist the cataclastic microstructure of which suggests strongly a sedimentary origin.

[1/3699, S. 4517.] Spring, East of Tower Peak, Mount Ragged Range. Macroscopic features: A pinkish, medium-grained somewhat saccharoidal-looking quartzitic rock, the foliation planes of which are coated with scaly white mica. Microscopic features: In section the rock is similar to [1/3698] in that it is a quartz sericite schist, but it differs from [1/3698] in fabric. The quartz grains are much larger, their average diameter being about 1/40 of an inch. These large quartz individuals are wrapped round and separated by a very fine grained quartz sericite mosaic. The mica rods are, in places, squeezed and drawn out between the large quartz grains. The section shows strong schistosity and the microstructure indicates a sedimentary origin.

A representative suite of the rocks from the Mount Ragged Range has been analysed in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson:—

TABLE I.

Chemical Analyses of Rocks from Mount Ragged Range.

Registered No., Name, and Locality.	1/3698. Quartz Sericite Schist, South end of Mt. Ragged.	1/3699. Quartz Sericite Schist, Spring East of Tower Peak, Ragged Range.
SiO_2	92·46	90·46
Al_2O_3	4·11	4·88
Fe_2O_3	1·34	1·47
FeO	·08	·10
MnO	·09	·15
MgO	·42	·42
CaO	*Nil*	·09
Na_2O	·04	·02
K_2O	1·26	1·49
LiO_2	...	*Nil*
H_2O-	·08	·04
H_2O	·53	·67
TiO_2	·11	·11
P_2O_5	*Nil*	·05
ZrO_2	trace	...
CO_2	*Nil*	·07
FeS_2	*Nil*	·11
	100·52	99·85
Sp. Gr. ...	2·69	2·69
Analyst ...	H. P. Rowledge	H. Bowley

The open bay, with a base trending generally northwest and southeast, lying to the westward of the bold headland of Cape Arid and the cape to the south of Tragon Harbour, near the mouth of the Thomas River, in all probability has been determined by the fractures which are responsible for the formation of the bold Mount Ragged Range and that to the east, of which Mount Dean forms the most prominent feature and upon which the Trig. Station has been built.

The shape and general northeasterly arrangement of the coastline from Cape Paisley through Israelite Bay to the neighbourhood of Wattle Camp, suggests that it has been in the main determined by that of the trend of the foliation of the gneisses, which is also parallel to that of the ranges referred to.

Point Dempster, a bold headland which shelves gradually into the ocean, is made up of a coarse granitic gneiss, upon which rest sand dunes. The headland is probably continued to the southeast and forms the bold islands of the "Eastern Group," which lies about two miles from the coast. About four miles northeast of the Israelite Bay Telegraph Office, and on the western side of the telegraph line, are a series of low rises made up of granitic gneiss of the type which characterises Point Dempster; the gneiss is first seen near the northern end of the Yellow Lake, which crosses the northern boundary of Reserve 3805. Near the sea coast the gneisses are covered by blown sand. Similar gneisses are visible along the north-western shores of that long salt lagoon, which extends from Point Malcolm to Point Dempster. The road from Israelite Bay to Mount Ragged skirts the northwestern shores of the lake and surmounts the tableland of the interior at an altitude of about 500 feet by aneroid above sea level. The summit of the tableland, about 12 miles from the Post Office, is made up of granitic rocks, upon which there is a thin covering of horizontal white limestone, forming a low escarpment representing in all probability the southerly extension of the Eucla Limestone.

Leaving the Mount Ragged Range, the main road to Balladonia was followed, and at Junana Rocks gneissic rocks of the prevailing type are exposed. A characteristic specimen has been described by the Acting Petrologist as:—

[1/3697, S. 4513.] Junana Rocks, North-West of Mount Ragged, Neridup District. Macroscopic features: A white granulose rock with gneissose structure and well-marked foliation planes coated with black lustrous biotite. When viewed along the cross fracture the biotite takes the form of disconnected black streaks averaging about 1/5th of an inch in length, though in places the streaks are half an inch long. The granulated material consists of glassy quartz and felspar, many plates of the latter showing cleavage faces. Microscopic features: The minerals observed were quartz, microcline, plagioclase and biotite. In plain light the section is made up of a holocrystalline aggregate of slightly clouded and cleaved felspar, clear quartz and flakes of brown biotite. The bulk of the felspar has a refractive index less than Canada balsam and shows typical cross-hatched twinning. It is therefore microcline, possibly with a little orthoclase. There is a small amount of acid and finely striped plagioclase. The quartz is clear, allotriomorphic and intergrown with microcline in granitic fashion. The biotite occurs in flakes, strongly pleochroic, in dark brown to almost black colours. The rock is a granulated biotite gneiss of igneous origin.

* Census of the Minerals of Western Australia: E. S. Simpson. Guide Book to the Western Australian Museum, Part VI., Minerals. Perth. By Authority, 1912.

The road from Junana trends generally due north to what is known as Pine Hill, where there is an excavated tank. The rocks in the neighbourhood are fine-grained granitic gneiss traversed by pegmatite dykes. A typical specimen of the gneiss has been examined and described by Dr. Larcombe:—

[1/3702, S. 4520.] Pine Hill, Dempster District. Macroscopic features: An even grained pink to flesh-coloured rock of aplitic texture and somewhat granulose appearance. The constituents are glassy quartz and cleavage facets of felspar. Small flakes of black biotite, with a tendency toward parallel arrangement, are uniformly scattered throughout the rock. Microscopic features: The minerals observed were quartz, microcline, orthoclase, and biotite. In section the rock is an even grained admixture of quartz and microcline in about equal proportions, with, if anything, more microcline than quartz. The quartz is colourless, shapeless, and intimately intergrown with microcline in granitic fashion. The microcline is for the most part hypidiomorphic with well developed "gridiron" texture. A few plates of plagioclase, with very finely striated lamellae and extinction angles of less than five degrees are evidently oligoclase. Dark brown lath-shaped flakes of biotite, with a parallel arrangement of their direction of elongation, are uniformly distributed throughout the rock. The rock is a fine-grained aplitic biotite microcline gneiss. It bears a strong resemblance to [1/3697] and evidently belongs to the same family. It differs textually from [1/3697] in being finer in grain and typically aplitic as well as not being so gneissic. On the other hand, it has the same mineralogical constitution as [1/3697]. The biotite is identical in pleochroism and the plagioclase is quite similar.

An analysis of this rock is given in the table appended. Gneissic rocks occupy the country as far north as Pownia, to the west of Curnading Rock.* At Pownia the gneisses are vertical, and have a general strike of north 20 degrees east. The gneisses of Pownia give place at Balladonia Station to coarse grained massive granite, made up of quartz, microcline and biotite, with a little magnetite, rising to a height of about 50 or 60 feet above the general level of the limestone [1/3703], by which it is everywhere surrounded, and covering an area of about 200 acres. The granite is traversed by pegmatite dykes. The limestone, which is very hard, is only about five or six feet thick, and rests upon a thin bed of reddish sandstone which directly overlies the granite. A suite of fossils was collected from the Balladonia limestones, but this yet awaits determination and description. The limestones of Balladonia form the western portion of the Miocene beds, which constitute the Nullabor Plains. The limestone occupies a portion of the country along the road to Newman's Rocks* for about 20 miles with two relatively small outcrops of granitic rocks at Booma Rocks and Woolganyia (Wahgoninya or the 15-Mile Rocks); at the latter locality the granite is lithologically identical with that at Balladonia, being very coarse in grain.

Newman's Rocks (264/97) are made up of coarse garnetiferous gneiss, which rises to a height of about 60 feet above the general level of the surrounding country. These gneissic rocks occupy the country as far as Fraser's Range; they are, however, intersected by basic dykes, one of which has a north-westerly strike, being met with on the main road at about six miles from Newman's Rocks.

The whole of the country, therefore, inland between Esperance and Israelite Bays is made up of gneissic rocks of igneous origin, which have had impressed upon them a dominant northeast and southwest foliation. They are traversed by numerous pegmatite dykes, and so far as observations have been carried these appear to have escaped sensible mechanical deformation; hence they are of a younger generation than the gneisses, which occupy a stratigraphically inferior position.

Fraser's Range.—Passing through Fraser's Range, "Orrallinna," *en route* from Balladonia to Norseman, exigencies of travel necessitated a day or two's delay at the Fraser's Range head station, latitude 32° 2′ 15″ S., during which opportunity was taken to make a very brief examination of the country in the vicinity, and to collect samples of the different rocks for investigation.

Numerous references to the geology of the Fraser's Range have been made in several publications issued since 1891, but no systematic description and investigation of the country within the limits of the Fraser's Range has yet been attempted nor been found possible.

In the year 1890 a well organised party equipped by Sir Thomas Elder with the object of exploring the country to the westward of Warrina, on the Great Northern Railway line, 633 miles from Adelaide, lying between the parallels of 27° and 29° South latitude, spent some time in the vicinity of Fraser's Range. The brief account of the geology was written by Mr. Victor Streich, the geologist attached to the party, and published as part of the Scientific Reports of the Expedition by the Royal Society of South Australia.†

The highest summit of the range, The Peak, was determined by hypsometric measurements as being 2,010 feet above sea level, and 761 feet above the station hut. The loftiest portion of the range was stated to be about 15 miles in length with a width of from six to eight miles, though it really has a very much greater extension and gradually merges into the surrounding country.

The main mass of the Fraser Range, according to Streich, consists of indistinctly striated hornblendic schists, traversed by more or less parallel granitic dykes, the outcrops of some of which stand up above the surrounding country like walls of masonry.

The distinctly banded rock, forming the main mass of the range, collected and described by Streich as hornblende schist, was submitted with the others in the collection to Professor A. W. Stelzner, of Freiberg, who referred to it as "an undecomposed diabase."‡

In 1911 Mr. J. Allan Thomson¶ re-examined the duplicate collection and described the rock as "a norite with feeble protoclastic structure, and well marked fluxion banding"; the rock was made up chiefly of schillerised hypersthene, with a little mica and very little hornblende.

Mr. H. P. Woodward, in 1894, gave the geological constitution of the Fraser's Range as being that of

* Lands and Surveys Department Lithograph 17/300. † Trans. Roy. Soc., S.A., Vol. XVI., Pt. II., 1893, p.p. 74–115. ‡ Loc. cit.
¶ Thomson, J. Allan: On Rock Specimens from Central and Western Australia, collected by the Elder Scientific Exploring Expedition of 1891–2.—Proc. Roy. Soc., N.S.W., Vol. XLV., 1911, p.p. 292–317.

massive hornblendic rocks, intersected by basic dykes together with "quartz blows and veins of magnetite and manganese."*

During the course of his investigations into the geology of the country traversed by the Trans-Australian Railway, Mr. C. G. Gibson† referred to the Fraser's Range as being made up of rocks varying from garnetiferous quartz-schist to garnetiferous biotite-gneiss, intersected by coarse-grained pegmatite dykes containing books of mica about two inches square, large crystals of tourmaline, and some allanite.

The two trig. stations, Mount Pleasant‡ to the north, and Wyralinu to the south, of the homestead at Fraser's Range, are made up of garnetiferous pyroxene-gneiss [1/3700] and [1/3707], which may be merely granular varieties of the hornblende granite [1/3704] and [1/3706] frequently met with in the country between the range and Norseman.

The hill known as Mount Pleasant is made up of garnetiferous-gneiss [1/3700] and gneissic hypersthene-gabbro [1/3719] with a marked northeast and southwest vertical banding. The individual bands are not very wide, reaching in the vicinity of the trig. station on Mount Pleasant a thickness of about three of four feet.

A basic rock [1/3707] with a very marked mineral banding forms Wyralinu. The strike of the banding is northeast and southwest, and the rock is virtually a garnetiferous gneiss; it contains in places very large crystals of felspar, too much decomposed, however, to enable specimens to be obtained.

At the Fraser's Range station is a biotite hypersthene-gabbro or norite [1/3708], exhibiting a distinct mineral banding identical in its character with that which constitutes the gneissic gabbro [1/3719] of Mount Pleasant. A similar garnetiferous pyroxene gneiss has recently been obtained by Mr. Inspector of Mines Phoenix from Simon's Hill, about 20 miles to the northeast and near the northern extremity of Fraser's Range. The rock has been examined by Dr. C. O. G. Larcombe, the Acting Petrologist. The gneisses of the Simon's Hill neighbourhood vary somewhat in their lithological character, passing in places from garnetiferous quartz-schist to garnetiferous biotite-gneiss. These gneisses extend over a considerable area of country, and form part of that belt occurring at Bunnginia, about 40 miles to the northeastward, where the trend of the foliation is also northeast and southwest.

According to the observations of Streich, as indicated in the section forming Fig. 12 of Plate V., accompanying the scientific results of the Elder Exploring Expedition, the Fraser's Range is made up of hornblendic, felspathic, and siliceous schists.

The southeastern extremity of the Fraser's Range, about 22 miles from the head station, is stated to be made up of "hornblende schist."

The configuration of the range appears to have an intimate connection with the trend of the banding of the rocks, which is on the whole northeast and southwest.

Four analyses of the rocks in the vicinity of Fraser's Range have been made in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson:—

TABLE II.

Chemical Analyses of Rocks from Fraser's Range.

Registered No., Name, and Locality.	1/37 0. Garnetiferous gneiss, Mount Pleasant.	1/3707. Garnetiferous gneiss, Wyralinu.	1/3708. Norite, Fraser's Range Station.	1/3719. Norite, Fraser's Range.
SiO_2	60·86	77·10	49·11	52·21
Al_2O_3 ...	14·79	11·89	16·98	17·37
Fe_2O_3 ...	1·12	·36	1·94	·78
FeO	7·05	·80	8·87	8·55
MnO	·28	·15	·37	·47
MgO	2·17	·44	8·44	6·43
CaO ...	4·91	1·31	9·69	8·67
Na_2O ...	2·02	1·68	2·29	2·60
K_2O ...	4·48	5·90	·81	1·38
H_2O	·08	·08	·06	·09
H_2O	·22	·03	·52	·03
TiO_2	1·60	·29	·95	·60
CO_2	·04	·06	*Nil*	·89
P_2O_5	·46	·15	·24	·18
FeS_2	...	*Nil*	·04	·09
Cr_2O_3 ...	...	...	·06	·02
	100·08	100·24	100·37	100·36
Sp. Gr. ...	3·02	2·64	3·05	2·98
Mode ...	Felspars Quartz Garnet Augite Ilmenite Apatite Magnetite Zircon	Felspars Quartz Garnet Augite Hornblende Magnetite Ilmenite Apatite Limonite Zircon	Andesine Hypersthene Hornblende Biotite Ilmenite Apatite Limonite	Andesine Hypersthene Hornblende Biotite Calcite Quartz Ilmenite Apatite Pyrite Zoisite Zircon
Class ...	...	...	III.—5, 4, 4 Auvergnose	
Analyst ...	J. N. A. Grace.	J. N. A. Grace.	H. P. Rowledge.	H. E. Hill.

The principal point of interest and importance brought out by the reconnaissance of the country in the vicinity of Fraser's Range is the igneous nature of the rocks examined. Some of these are characterised by the presence of hypersthene, garnets and a marked persistent mineral banding. These rocks appear to bear some resemblance to that group of hypersthene-bearing rocks of India (the Charnockite series) and elsewhere.

Hypersthene bearing rocks, however, have already been described from Norseman, on the Dundas Goldfield, 60 miles east from the Fraser's Range. The hypersthene rock (norite) of Norseman occurs as an east and west dyke, varying from half a mile to a mile in width, which has been proved to extend in an uninterrupted line about 12 miles eastward as far as Mount Norcott, and for a considerable distance to the westward of Norseman itself. This rock, which bears some resemblance to that at Fraser's Range, if not actually part of the same rock mass, exhibits noticeable variations "ranging from hypersthene, through olivine norite to quartz norite with enstatite augite and pyroxene-perthite in many of the specimens." Detailed chemical analyses of the Norseman norite are given in Table "C" on pages 30 and 31 of Bulletin 67, "Analyses of Western Australian Rocks, Meteorites, and Natural Waters," by Edward S. Simpson, 1916.

Norites have also been described from Ora Banda, Broad Arrow Goldfield [12466]; from Cue, Murchison Goldfield [3832]; and from the Cavenagh Range, Eastern Division [1/1099], [1/1098], and [1/1107]; whilst at Cohn Hill, in the same division, a garnetiferous hypersthene-gneiss [1/1095] occurs, which resembles the gneisses of Fraser's Range, where it is associated with other rocks similar in character to those constituting the Charnockite Series of India.

* Woodward, H. P.: On the Country between Broome Hill and the Dundass Hills and the Mines in that neighbourhood. Ad. interim Report of the Department of Mines for the year ending 30th June, 1894. Perth: By Authority, 1894, p.p. 17–18.

† Gibson, C. G.: The Geological Features of the country lying along the route of the proposed Transcontinental Railway in Western Australia.—Geol. Survey Bull., 37. Perth: By Authority, 1909, p.p. 4–21.

‡ Lands and Surveys Department Lithograph 17/300.

Following the main road from Fraser's Range Station to Norseman, the basic rocks continued for about seven miles, when they gave place to granitic gneiss at what is known as the Ten Mile Rock.* The gneiss at the Ten Mile Rock is vertical, and has an average strike of north 10 to 15 degrees east. At a rock hole 38 miles from the station a hornblende microcline granite (soda granite) [1/3704] occupies the country and continues as far westward as Buldania Rocks (A.8) to the north of Mount Northcott [1/3706]. The granite continues as far as Norseman, where its apophyses, the quartz-porphyries and the soda-porphyries (ceratophyres), penetrate all the rock series developed on the field other than the metamorphic sedimentary beds and the newer norite dyke.

Chemical analyses of the two soda-granites and two gneisses were made in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson; these are given in Table III. hereunder.

TABLE III.

Chemical Analyses of some Rocks from the Country between Mount Ragged Range and Norseman.

Registered No., Name, and Locality.	1/3702. Biotite gneiss, Pine Hill.	1/3697. Microcline biotite gneiss, Junana Rocks, North West of Mt. Ragged.	1/3704. Soda granite, Rock Hole, 38 miles East of Fraser's Range Station.	1/3706. Soda granite Buldania Rocks (A. 8).
SiO_2	75·00	73·23	71·32	69·88
Al_2O_3 ...	12·57	12·78	15·14	15·18
Fe_2O_3 ...	·85	1·06	·67	1·21
FeO	1·00	1·98	·54	1·19
MnO	·15	·15	·08	·12
MgO	·17	·50	·43	1·13
CaO	·87	1·27	1·47	2·86
Na_2O ...	2·90	3·66	5·25	4·78
K_2O	5·82	4·92	3·14	2·15
H_2O — ...	·04	·03	·16	·06
H_2O + ...	·23	·46	·40	·60
TiO_2	·24	·48	·11	·31
P_2O_5	·07	·17	·57	·15
CO_2	*Nil*	·02	·20	·04
FeS_2	*Nil*	*Nil*	*Nil*	trace
S	...	...	·13	...
			99·61	
Less F ...	...	...	0·06	...
	99·91	100·71	99·55	99·66
Sp. Gr. ...	2·63	2·66	2·65	2·68
Mode ...	Microcline Quartz Oligoclase Biotite Magnetite Limonite Sphene Apatite Riebeckite (?) Garnet (?)	Microcline Oligoclase Quartz Orthoclase Biotite Hornblende Sphene Magnetite Calcite Apatite Riebeckite	Oligoclase Quartz Microcline Hornblende Epidote Biotite Apatite Magnetite Calcite Sphene Fluorite Limonite Kaolin	Oligoclase Quartz Microcline Biotite Hornblende Epidote Muscovite Zoisite Sphene Magnetite Ilmenet Apatite Limonite Zircon
Class ...	I.—4 (3), 1 (2), 3 Liparose, near Alaskose and Toscanose	I.—4, 1(2), 3 Liparose, near Toscanose	I.—4, 1, 4 Kallerudose	I.—4, 2, 4 Lassenose
Analyst ...	D. G. Murray.	D. G. Murray.	H. P. Rowledge.	J. N. A. Grace.

In addition to the magnetite and manganese referred to in the report by Mr. Woodward, previously quoted, ilmenite (titanite of iron) occurs in some portion of Fraser's Range, for a sample of this was handed to me while at the head station. No opportunity, however, presented itself of making an examination of the locality from which the mineral was obtained.

4.—THE GYPSUM DEPOSITS AT DUKIN, AVON DISTRICT, SOUTH-WEST DIVISION.

(F. R. Feldtmann.)

Geography.

Location.—Dukin Siding is situated in the Avon District on the Wyalcatchem-Mount Marshall branch railway about 115 miles NE. of Perth, as the crow flies, and approximately 159 miles by rail. It is close to the southeastern edge of Cowcowing Lake, a large and, in this area, comparatively well-defined salt lake, extending in a southwesterly direction.

Mineral Claim 29H—the only area being worked during my visit—is situated on the southeastern edge of the lake from half a mile to a mile north of the siding. It is within Location 16454,† formerly held by the Plaster of Paris and Gypsum Company, Ltd., and adjoins part of the western boundary of Lot 124.

Topography and Vegetation.—The surrounding country is gently undulating, there being no hills of any size. There is, for the most part, a gentle slope towards the lake, but in places the lake is fringed by fairly steep, but comparatively low, banks.

The chief timber is salmon gum, which is fairly thick on those areas left uncleared. Some small areas of ti-tree occur along the edge of the lake.

Geology.—The country is largely covered by detrital material, the surface soil being of a fairly light sandy character. A few fragments of travertine were seen in places.

The underlying rock is, without doubt, granite, but only one small outcrop, on the northwest shore of the lake at a point 3¼ miles NW. of the siding and immediately north of the re-entrant angle of Location 18932, was seen. This outcrop was in the form of a low breakaway, and consisted of much decomposed granite, showing incipient laterisation at the surface.

The Gypsum Deposits.—Cowcowing Lake consists, in the vicinity of Dukin, of a number of small clay pans, either more or less oval in shape, or forming narrow winding channels, of which one follows the southeastern edge of the lake. These clay pans are separated by low irregular banks composed chiefly of fine clay and sand, with some gypsum in the form of crystals or the earthy variety kopai, and in places small gasteropod shells and fragments thereof.

The bed of the clay pans consists of a dense, fine, puggy grey clay, extending in potholes in Mineral Claim 29H to a depth of about five feet. A pothole a few feet from the edge of the lake shows the material underlying the grey clay to consist of clay of paler and more reddish colour, containing a large proportion of quartz grains. This deposit was exposed to a depth of about four feet, but no information was available as to its total depth.

The gypsum deposits appear to be chiefly confined to the southeastern side of the lake. In the dry season the floor of the clay pans on this side of the lake, with the exception of the lowest-lying portions, is covered by a layer of gypsum, mainly of the seed type. This layer ranges in thickness from a mere film to nearly a foot. The main deposit on Mineral Claim 29H is usually from four to six inches in

* Lands and Surveys Department Lithograph 18/300. † *Vide* Lands and Surveys Department Lithograph 56/80.