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DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. F. PITTMAN, A.R.S.M., Government Geologist.

MINERAL RESOURCES.
No. 19.

GEOLOGICAL SURVEY

OF

THE CARGO GOLD-FIELD.

BY

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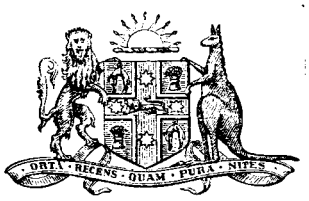

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LETTER OF TRANSMITTAL.

Department of Mines,
Sydney, 29th January, 1915.

Sir,

I have the honor to submit for publication a Report (No. 19 of the Mineral Resources Series) on the Geology of the Cargo Gold-field, by Mr. E. C. Andrews, B.A., Geological Surveyor, and Mr. M. Morrison, Assistant Geological Surveyor.

Like many other gold-fields, Cargo has suffered for some years from a cessation of mining operations, and it is with the object of assisting it to a return of prosperity that the geological examination recorded in this Report was authorised. The authors describe the early history of the field, its geological formations, the character of its gold deposits, and the causes of its present quietness.

I have the honor to be,
Sir,
Your obedient servant,
EDWARD F. PITTMAN,
Government Geologist.

The Hon. J. H. Cann, M.P.,
Minister for Mines.

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[Geological Map of the Cargo Gold-field.]

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INTRODUCTION.

Owing to the lengthy period which has elapsed since mining operations, of an important nature, have been conducted at Cargo, the underground workings were not accessible during the geological examination of this field in December, 1913. For this reason the value of the present report is considerably limited, inasmuch as, in the absence of knowledge gained by a study of the geological features as exposed in the mining excavations, it has been based, necessarily, upon a geological examination of the surface, of small surface openings, and of spoil heaps, as also upon a knowledge of the literature dealing with the field from 1870 to the present, and upon records of operations supplied by Messrs. John McMahon and M. Hennessy, of Cargo.

From a careful study of all the available lines of evidence, it would appear that the failure of mining in this district, up to the present, has lain, not so much in the absence of gold itself from the reefs, as in, first, the narrowness of and lack of definiteness in the gold-bearing channels themselves; second, the patchy nature of the pay ore; and third, the difficulty experienced in treating the sulphides with which the gold is intimately associated below the oxidised zone.

Communication with Sydney is maintained partly by rail and partly by road, the distance from Sydney to Orange by rail being about 195 miles, and thence to Cargo by road, being 23½ miles. The road is very hilly, a rise of 1,000 feet being experienced in the first 8 miles from Cargo towards the Orange plateau; nevertheless the surface is hard and fairly even.

History.—Access has not been had to the literature dealing with the discovery of the field, and passing references only are made to the field itself in both the "Industrial Progress" of New South Wales for the year 1870, and the Parliamentary Papers of 1873-4. An interesting and instructive article, however, by Mr. Mining Registrar Hutton, dealing with Cargo,* appears in "Mines and Mineral Statistics" of New South Wales for 1875, and in the general absence of other valuable and authoritative statements with respect to the field prior to 1875, it has been deemed advisable to reproduce, herewith, the Registrar's note in full, as being an epitome of the early history of the district:—

> "The most prominent feature of the Cargo Gold-field is the Ironclad Range, which is of considerable height, about 600 feet, and runs nearly south-south-east and north-north-west. This range seems to have been the feeder of the gold-field, as on it all the principal reefs are situated, and in nearly all the ravines leading therefrom gold in payable quantities has been found."
>
> "The gullies on the eastern side which have been worked with good results are as follows:—First, Long Gully, which was the first place rushed on this field, and which supported a mining population of from 100 to 500 miners for nearly two years. The next on the same side of the range is Township Gully, which was opened about the same time as Long Gully; it was also highly remunerative, one of the leads running down the centre of Cargo-street. The next was Graveyard Gully, which paid well for working."

* Pages 41-45.

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"On the western side of the range are:—First, Scrape Rock and Tin-dish Gullies. These gullies were very shallow, and were soon worked over, and produced a considerable quantity of gold. The next is Copper Gully, on which a good deal of work was done, but the amount of gold was not so great as in the others."

"All these leads have been abandoned for a time, but there is no doubt several of them will be reworked, and with good results. The reason of their abandonment was gold having been struck in Gum Flat, another gully on the same side of the range. When this gully was opened there was but a small mining population on the field, and the whole of the miners betook themselves to the new rush, where nearly all of them have remained ever since; the newcomers finding they could not get in on Gum Flat, did not care to set in to old ground of which they knew nothing, consequently left."

"Gum Flat was opened upwards of three years ago; the gold was first struck in a gully leading thereto, at a depth of 30 feet; from thence it was traced down the flat, on which there were several rich claims; Livemore and party had the best, some of their washings going as high as 4 oz. to the load, the depth varied from 30 to 50 feet, it was then for a time considered almost worked out, when a party tried to sink through the false bottom on which the gold had been got, at a depth of about 90 feet, came upon a vein of wash almost perpendicular or dipping slightly like a reef, and on this vein (which has been traced through nine claims) has the principal work been done for alluvial during the past year."

"Hicks and party's claim is supposed to be the best at present. This claim is somewhat different from the others; besides having the vein or lode, the same as the others, they have a flat bottom at about 100 feet over their entire claim, which yields well, and on this bottom they have been at work during the past year. Their best washing was 1 oz. to the load. Another very important claim is O'Donald and party's. This claim, although not so rich in gold as Hicks's, pays almost as well, the vein being wide and easily worked."

"Mackey and party's claim is the oldest claim on the flat. It has been worked by the present shareholders for upwards of three years, during which time it has paid from £3 to £7 per week per man. They worked it all over at about 45 feet deep, and now have commenced on the vein, which promises to pay them equally well."

"Odgen and party's claim has been more difficult to work than the others, the ground being harder and the vein narrower, and pitching about from side to side, making it difficult to follow. They have, however, persevered, and followed it down from 90 to 245 feet. This claim has paid well, and at their present depth the prospects are much better than they have been. This is the greatest depth to which the vein has been traced in any of the claims."

"Three other claims, viz., Holden's, McKay's, and Hogan's, have paid wages, and their prospects are improving. Further down the flat is Rickey and party's. They got the vein at 40 feet, and are following it down. This is really a good claim, the vein being wide, easily worked, and above the average in gold. Next to them is Groat and party. This claim is not so rich in gold as Rickey's, but is very easily worked, and a great quantity of stuff is got, which averages about 7 dwt. to the load. The vein has not been traced further than

this claim. It is impossible to say the exact quantity of stuff washed from these claims during the year; but, as near as can be ascertained, there has been 6,000 loads put through the machines, for an aggregate result of 2,800 oz."

"There is considerable speculation as to the future of Gum Flat, the formation being different from anything the diggers have experienced; it is the general belief, however, that the vein or lead extends a great deal further both ways than has yet been proved, the difficulty in finding it being very great, although the ground is easily sunk upon and worked, yet the vein being nearly perpendicular, with the same formation on each side of it, there is nothing to guide the prospector; he may sink within a few feet of it, and miss it; and again, in many places the vein is so narrow and poor that he may drive through it and not be aware of it. Some are very sanguine that the vein will lead them down to the main granite formation, where they expect to get something good. They seem to be assisted to this belief by the opinion expressed by the Rev. Mr. Clarke that 'on the western slope of the Canoblas there are heavy deposits of gold, but at great depth. There was a prospecting shaft put down on this flat, upwards of 300 feet, without finding the granite bottom; it was abandoned for want of means."

"There are a considerable number of known payable reefs at Cargo, nearly all of which are held under application to lease. They are as follows:—

Ironclad Reef.	Homeward Bound Reef.
Adelaide Reef.	Wreath of Roses Reef.
Pride of Cargo Reef.	Lucknow Reef.
Victim Reef.	Alpine Reef.
Dalcoath Reef.	Galatea.
Rise and Shine Reef.	Mobb's Reef.
New Chum Hill Reef.	Prince Alfred Reef.

"The owners of nearly all of these leaseholds are working on the alluvial at Gum Flat, and leave these tracts unworked for various reasons. First, they have remunerative employment where they are, and are not compelled to work these holdings until the leases are issued. Another reason is, during the first six months of the year there was only one crushing plant on the field, viz., the Rose of Denmark, the property of the Ironclad Company, who were nearly all the time crushing from their own ground, and when they did crush for the public they charged such a high rate that it cost £1 5s. per ton, viz., for carting and crushing, at which rate no poor reef would pay. There is now, however, another plant on the field, that of Wickins and Co., which was completed five months ago, but during three months of that they were unable to work for want of water; there is, however, a considerable quantity of quartz lying at several of the leaseholds, which will keep them constantly employed for a length of time. As soon as the leases are issued there is no doubt there will be ample employment for two more plants on the field."

"The vein in the Ironclad Company's leasehold runs nearly north-north-east and south-south-west; it has been worked to a depth of 178 feet, and 200 feet along the line of vein; it is nearly perpendicular; whatever dip it has is to the westward, it is in many places

12 feet wide, but will average 6 feet. There has been employed on this property during the past year from thirty-five to forty-five men; they have an excellent whim on the ground; the crushing plant has fifteen stamps, with a 25 horse-power engine; there is a buddle attached, which effectually separates the pyrites, of which they have a very great quantity; they have sent some of these to England to be treated; but are now about to erect a furnace, and will treat them on the ground. The company will not, however, give the slightest clue as to what gold, copper, or silver they get; they have expressed themselves well satisfied, and everything about the property indicates that it is paying very well. They have raised and crushed during the year about 4,000 tons, and it is the general opinion that it has averaged an ounce to the ton."

"The following is the result of the different crushings from this property previous to its purchase by the present company, viz. :—

1st crushing yielded	5 oz. 10 dwt. per ton.
2nd crushing yielded	5 oz. 15 dwt. per ton.
3rd crushing yielded	6 oz. 12 dwt. per ton.
4th crushing yielded (being 2 tons at the Mint)	13 oz.

About 30 tons were sent to England, and yielded 16 oz. gold, 9 oz. silver, and 35 per cent. of copper; there was also a large quantity of second-class stone crushed, which yielded about 1 oz. 5 dwt. per ton."

"The total quantity of quartz crushed on the field during the year has been, as near as can be ascertained, 6,000 tons for an aggregate yield of 5,000 oz.; this, together with the alluvial gold, viz., 2,800 oz., makes the total yield of Cargo Gold-field for the year 1874, 7,800 oz."

"There are two crushing plants at Cargo, with an aggregate of 37 horse-power and twenty-one head of stamps. There are nine dams on the gold-field—three in Copper Gully lately erected, supplying Wickin and party's crushing plants—one dam and a large reservoir supplying the Ironclad Company's plant—four dams in Cargo Creek, supplying three puddling machines which are constantly employed on the alluvial from Gum Flat; there is also a dam in Township Gully for domestic use."

"There are six leases of copper tracts on the gold-field, none of which have been as yet worked."

"There are on nearly all the ranges round Cargo very strong indications of both gold and copper, none of which have been proved; in fact there has been very little prospecting done in the district; there are at present, however, two parties out prospecting, one towards Toogong and another towards Cadia."

"The number of miners on Cargo during the year has been 150, and the entire population 400."

The first Annual Report of the Department of Mines was issued in 1875, and in this reference is made to the Victoria and Ironclad Reefs. Even as early as this the main shaft of the Ironclad was 270 feet in depth, and said to be the greatest depth attained in the Mining Division. At this

level the reef was reported to be better defined than at points nearer the surface, and 90 tons of pyrites taken therefrom were reported to have yielded a return of 180 oz. of gold.

A condition of active mining was maintained on the field until about 1879, both with regard to "alluvial" and "reefing." The alluvial deposits were of two classes, namely, shallow and deep "leads," of which the latter became known only after the shallow leads had been well prospected, the exploitation of the one leading to the discovery of the other.

With the close of 1879, a period of mining inactivity ensued for the Cargo Gold-field, which was closed by the reopening of the Ironclad in 1887, owing to an expenditure there of £150,000 by an English company. The period 1890-1898 was another of mining inactivity in the district, but during the years 1898-1900 another revival of the industry set in both at the Ironclad and the northern portion of the field lying towards the Commonwealth.

From 1904 until the present mining operations at Cargo have been almost at a standstill.

Physical Geography.

Drainage.—The township of Cargo itself is drained by the Bowen or Gerybong Creek heading in the Ironclad Hill, while the alluvial diggings of Gum Flat, 1 mile away to the west, are drained by the Cargo Creek, which heads in a low wide saddle about 2 miles to the north of the Cargo-Canowindra road. The courses of the two creeks are somewhat peculiar. Although the hills at Cargo attain no considerable elevation above the general level, nevertheless the Gerybong Creek flows for many miles to the north-west before turning to the south to join the Lachlan, while the Cargo stream flows southwards and discharges into the Canomodine, which in turn joins the Lachlan after being picked up by the westward-flowing Belubula River.

The catchment area of the Cargo Creek above the Gum Flat Diggings is extremely limited, being of the nature of a valley of insignificant length, but of moderate width, and hemmed in by ridges—apparently of Palæozoic rocks—rising several hundreds of feet above the valley base. The alluvial workings, however, reveal the presence of great amounts of buried river wash, which could not have been derived wholly from rock masses occurring in the local catchment of the present system, because the quartzites, forming a portion of the heavy wash, are not known to occur *in situ* within 3 miles in a direct line of the head of the present catchment. Evidently in the near past the configuration of the neighbouring country must have been decidedly different to that which it possesses at present, for at that time the valleys were 400 feet deeper at least than at present, while their walls, apparently composed of solid rock, must have been pierced by at least one, if not two, deep gaps, which are now filled up with river and hillside debris. In a later chapter it will be shown that the evidence points to the present long, low, and flat saddle in which the present Cargo Creek takes its rise as being due to the filling, by waste, of one of such postulated old and deep gaps. From any view-point whatever the present distribution of the local drainage suggests a profound modification of the stream courses in recent geological time.

Cargo itself lies about 1,850 feet above sea level, as determined by aneroid readings, using the Orange Railway Station as a bench-mark, and

it occupies portion of a surface of undulating nature which stretches northwards through Cudal and Molong. The valleys are broad and separated by ridges rising several hundreds of feet above the valley bases.

To the south-west and the west the country falls towards the great valley of the Lachlan, whose broad base lies about 1,000 feet below Cargo, while to the east the country rises, within a distance of 8 miles, to a height of 1,000 feet above the same locality. At this point, namely, Coffee Hill, the road passes over a long and broad spur of the Orange plateau. Before reaching the upland proper by road from Cargo, two valleys, each from 400 to 500 feet in depth, are crossed, and at 7 miles from Orange, at German's Hill, the upland plain proper is reached at an elevation of about 3,000 feet above sea level. This upland surface is of undulating nature, and is traversed by broken and discontinuous ranges rising to heights of from 500 to 800 feet above the general surface. On the edge of the plateau lies the volcanic pile of the Canoblas, reaching an extreme height of about 4,600 feet above sea level, and of later origin than the surface upon which it appears to repose. For a detailed account of this feature the reader is referred to the description by Sussmilch and Jensen.*

Climate and Soil.—The climate, while lacking the coolness of the neighbouring plateau, is not affected by the severe heat experienced on the low-lying country, as at Canowindra and Forbes.

The rainfall is also good, being about 25 inches per annum.

The soil of the hill slopes is of reddish, brownish, or chocolate colour, being eminently adapted for wheat cultivation, the rocks from which it has been derived consisting, in the main, of types possessing foods in abundance necessary to plant life.

Strong rock outcrops, with the exception of the siliceous porphyries, and the Devonian quartzites and sandstones to be described hereafter, are uncommon in the vicinity of Cargo itself, owing to the prevailing mantle of the reddish soil already mentioned.

General Geology.

The main geological features of the Mining District of Cargo itself consist of shallow and deep leads, lavas (siliceous and intermediate to basic in composition), Silurian sediments, and a series of dykes, mainly of basic types. Owing, in the first place, to the general similarity both in chemical composition of the more basic lavas and tuffs and their derived soils of reddish colour; in the second place, to the widely-spread existence of the red-soil mantle; and, in the third place, to the general obscuration of the rock masses themselves by such soil mantle of gentle slope, it was found almost impossible in a brief examination, such as that undertaken at Cargo, to attempt the mapping-in of each small patch of lava and tuffs. The presence of alluvial deposits much denuded caused difficulty also in mapping.

In mapping, therefore, it was considered advisable to confine attention to the junctions of the siliceous lavas with other igneous rocks,—such as andesites, dolerites, and their tuffaceous representatives as a whole—to the reef outcrops, the mine workings, and the main mass of the alluvium.

* "The Geology of the Canoblas Mountains." Proc. Linn. Soc. N.S.W., 1909, pp. 157-192.

SUMMARY OF GEOLOGY.

(*a*) *Recent.*—Shallow and deep leads.

(*b*) *Tertiary.*—Basalts with post-basaltic lavas of the Canoblas.

(*c*) *Devonian.*—Quartzites, sandstones, shales, tuffs, and claystones.

(*d*) *Silurian.*—Limestones, claystones, and tuffaceous sediments, with contemporaneous lavas and tuffs.

(*e*) *Ordovician* (?).—Contorted and metamorphosed sediments occurring as a small inlier in the Canomodine Creek, along Spring Creek road.

Recent or Post-Tertiary.—This period appears to embrace the formation of both shallow and deep leads at Cargo. The record of both is sedimentation after pronounced erosion at Cargo. Thus, at Gum Flat, buried river wash and carbonaceous sediments with leaf imprints occur at depths as much as 350 to 400 feet below the present surface. Superimposed upon these are great thicknesses of a ferruginous sandy clay flanking an irregular but steeply pitching mass of coarse wash lying against the now-buried valley wall on the eastern side of the valley, while above these sandy beds, in turn, one finds wide and thick fans of angular and sub-angular wash, the apices of the fans, or cones, heading in some gully draining the western slopes of the Ironclad Range.

Of these the wash of the upper alluvial fans has a local origin, but the more deeply-seated material only belongs in part to the present catchment, having been derived in part from some other catchment separated to-day from the present one by ridges of moderate height. A peculiar feature of the deeply-seated wash is its steep angle of dip, reported as almost vertical in places to depths of hundreds of feet from the present surface. It is evident that by whatever agency formed, these deeply-buried drifts were laid down under a set of geographic conditions differing widely from those obtaining at the present day. Still another, and widely-spread, set of gravels occur as outliers upon the ridges many hundreds of feet above the deep-lead gravels. These belong to a much older set of geographic conditions when the topography of Cargo appears to have been of less relief than at present, but from 500 to 700 feet above the bases of the deep leads.

Another point of interest, in connection with the recent geological history of Cargo, is the formation and still later degradation of the alluvium capping the deep leads under consideration. An examination of the present surface of Gum Flat, and the low, flat, saddle in which it heads, shows a variation in vertical height of, at least, 200 feet, while the "leads" lie at depths of as much as several hundreds of feet below the surface of the present alluvium. This alluvium, in turn, possesses a very irregular profile, clearly indicating a great degradation of its primitive level surface. On account of the presence in the deep leads of boulders not now occurring *in situ* in the present catchment, it is evident that portions of the valley walls now rising as ridges above the present alluvium, must be composed of recent sediments, these being left in their present positions during subsequent denudation.

The vertical, or almost vertical, dip of the Gum Flat wash, in places, as recorded by various writers, is an interesting feature. The explanation supplied on a later page appears to be the most feasible in view of

the incomplete nature of the evidence. In this connection, it is significant that, in driving at a depth, limestone walls were reported to exist at the lower portion of the lead.

Tertiary History.—It is evident to the casual observer that the Cargo-Molong area appears to form a sub-horizontal surface overlooking the broad and deep valley of the Lachlan, while this same surface, in turn, appears to form a wide bench, undulating to hilly in nature, rising by an intermediate step on to the extensive surface of the Orange plateau.

The idea thus gained of these wide surfaces lying west and south of the Orange plateau is that they are valley-in-valley structures, older, on the one hand, than the auriferous leads, and younger, on the other, than the general plateau surface.

Upon the surface of the plateau—or 3,000 feet level—lies the volcanic pile of the Canoblas, a platform of basalt forming a layer between the volcanic pile proper and the plateau. Comendites, trachytes, andesites, and tuffs comprise the main volcanic rock types. The siliceous members of the lavas solidified rapidly, and built up steep lava cones, while the more basic types possessed greater fluidity, and have spread away from the steeper portions of the mountains proper. These rocks have been described in detail* by Mr. C. A. Sussmilch and Dr. H. I. Jensen.

Under the basalts of the plateau, as at Forest Reefs, numerous fossil plant remains have been found. These have been referred to the Upper Pliocene period by observers such as Baron von Mueller, but it is doubtful whether the immense amount of erosion, which the district has suffered subsequently, could have been accomplished in a brief division of the Geological Record, such as the Pleistocene. For not only have the basalts covering these leads been denuded to form wide valleys possessing very broad bases, but the great valleys in turn, in which the present Lachlan flows, have been excavated during still later periods. Not only so, but the evidence of the fossils themselves is such as to suggest a greater age for them than late Pliocene. For the types, numerous as they are, consisting of *well preserved fruits, not of indeterminate leaves only,* are widely distributed throughout leads in Eastern Australia. Nevertheless, with about two exceptions, these numerous genera are now extinct. Such wholesale extermination of genera is suggestive of a process occupying a period of time exceeding the Pleistocene in length.

The Canoblas Mountains are considerably younger than either the basalts and the leads just mentioned. Physiographically they are young, as there are waterfalls of moderate height on their sides. The Hopetoun Fall, 180 feet in height, is an example. On this account it would, perhaps be preferable to consider the Canoblas eruptions as occurring in the latest division of the Tertiary†.

In the present report the sub-level surface within which Cargo and Molong are situated, has been considered as an old and broad valley-level of the Lachlan drainage, now occurring at a height of from 2,100 to 2,300 feet above sea-level, but in the paper by Sussmilch and Jensen the possibility of a fault is suggested. "To the west of this line the tableland is much lower. At Molong, for example, the altitude of the peneplain is

* "The Geology of the Canoblas Mountains." Proc. Linn. Soc. N.S.W., 1909, pp. 157–192.

† See also Sussmilch and Jensen, *ibid.*, p. 171, and Plate IX.

only about 2,000 feet. It is quite possible, therefore, that an important fault may occur here, separating the Orange portion of the uplifted peneplain from that part immediately to the west."*

The work of the present survey, as also the reconnaissance work of Mr. L. J. Jones and one of us, was not of such a nature as to actually settle this important question, nevertheless a strong case *a priori* has been made out for a general elevation and tilting to the westward of the old plain of erosion, with later developments of broad valley-in-valley forms during the elevation of the plain to form a plateau. In this connection one peculiar feature concerning the arrangements of the basalts should be mentioned. Lavas of this type occur both above and below the high escarpments of Devonian sandstones and quartzites lying north-east of Cargo, without trace of the lava clinging to their faces. This feature could be explained satisfactorily by calling in the aid of either erosion or faulting.

Devonian.—In the area mapped, no exposures of Devonian sediments occur. The deeper gravels of Gum Flat, however, contain numerous pebbles almost undoubtedly derived from the Devonian quartzites lying a few miles to the east of Cargo. These are associated with sandstones conglomerates, and tuffaceous beds. The quartzites and sandstones form bold landmarks owing to their relatively great resistance to the forces of erosion, while the shales have been removed in great measure.

From Gap Creek, about 8 miles north of Cargo, Mr. Sussmilch† obtained numerous specimens of Lingula gregaria, Spirifer disjuncta, Rhynchonella pleurodon, and Chonetes.

The Silurian.—The greater portion of the Cargo rocks appear to belong to Silurian types, and consist of claystones, fine and coarse-grained tuffs, limestones, associated with igneous rocks of various types but of undetermined age, such as andesites, trachytes, dolerites, and pitchstones with breccias and tuffs. The aggregated thickness of the sediments and the igneous rocks is considerable. At Cargo itself the main types consist of contemporaneous lavas, with other igneous rocks which may be intrusive into the general mass of the lavas, or which may be in part, also, of the nature of a denuded volcanic plug. With these are breccias and tuffs, and a great development of sediments which appear to be of the nature of claystones, but which, upon closer inspection, have been ascertained to consist of tuffaceous material, intermediate to basic in composition. The claystones are well bedded, and in places are suggestive of slates. About 3 miles to the north-west of Cargo, the claystones exposed in a creek along the Cudal road have a strike almost meridional, and an almost vertical dip. Crumpling is also pronounced at this spot.

The development of limestone is marked, not in the area mapped, but in the vicinity. Along the Spring Creek road, about 4 or 5 miles to the south-east of Cargo, these rock types have a strike almost north-west and south-east, and a dip of about 20 degrees to the north-east. They are well bedded, occurring mainly in thin layers, and containing fossils. Subjacent is a thick mass of coarse breccias of basic composition, while these in turn rest upon well-bedded blackish tuffs, of very fine texture, and in which trilobites were found.

All these types exposed in this fine section possess gentle dips, and rest upon a mass of reddish sediments, intensely crumpled and altered.

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* Sussmilch and Jensen, *ibid.*, p. 162.

† Silurian and Devonian Rocks west of the Canoblas. Proc. Roy. Soc. N.S.W., 1906, pp. 130-141.

The igneous rocks of the Cargo area are described under a separate heading.

The limestones of the area have been mapped by Mr. Jones, and by one of us, and numerous Silurian fossils have been procured from Bowan Park and other localities within a few miles of Cargo.

The following list of fossils from Bowan Park, and the accompanying notes on them, have been supplied by Mr. W. S. Dun, Palæontologist to the Survey:—

Syringoporoid Coral	Trematospira	Naticopsis
Columnopora (?)	Lophospira	Lituites
Heliolites	Hormotoma	Crinoid stem ossicles.

"The Bowan Park Silurian fauna is quite distinct in its facies from those recorded from any other locality in the State. (It is impossible, however, to say, in view of our comparatively limited knowledge of the zonal and geographical distribution of our Silurian faunas, what position these beds occupy in the system.)"

Specimens of a trilobite (Proetus) have also been secured from certain fine-grained tuffs, in a road section, about 5 miles south-east of Cargo.

It must be remembered that although the tuffs, the limestones, claystones, and other sediments in the immediate vicinity of the Ironclad Range, are Silurian in age, nevertheless the exact age of the auriferous rocks of Cargo itself has not been ascertained. The igneous rocks in which these ore deposits occur have been altered to a considerable extent by the development within them of epidote and other minerals, and it is possible, if not indeed probable, that the small area occupied by them may prove to be an inlier of pre-Silurian rocks.

In support of this statement it may be interesting to note the pre-Silurian age of sediments containing auriferous deposits in the Central Western district of the State whenever determinative fossils have been secured from such areas.

Ordovician(?)—As mentioned earlier, the existence of Ordovician sediments and igneous rocks is inferred rather than proved. Rocks of this age are known to exist in abundance both within the County of Ashburnham and its neighbourhood. Metamorphism is a characteristic feature in such Ordovician rocks. Furthermore, the auriferous deposits of economic value appear to lie within sediments of this nature in the district. In the Cargo area the igneous types are much altered, and contain gold-bearing reefs, whereas the rocks of definite Silurian age in the district have been prospected unsuccessfully for payable gold reefs. Again, in the Canomodine Creek, about 5 miles to the south-east of Cargo, a small patch of altered and crumpled sediments occur underlying Silurian limestones and tuffs of gentle dip.

Igneous Rocks.

The igneous rocks of Cargo consist mostly of lavas and hypabyssal types, with breccias and tuffs. Siliceous types are well represented, as also others of andesitic, trachytic, and doleritic character. All appear to be older Palæozoic in age, neither the Tertiary basalts nor the Canoblas comendites, trachytes, and andesites, being found within 2 miles of the area mapped.

Field Notes.

Siliceous types.—These comprise the felsites and quartz-felspar-porphyries of Cargo. With them occur coarse breccias in certain places, as at Copper Gully. At the latter spot brecciation is a marked feature. Other breccias

may occur also in association with the siliceous porphyries, nevertheless unobserved during the progress of the survey owing to the difficulty of detecting these structures except on surfaces of recent exposure. The texture varies considerably, the rock appearing indifferently as a felsite of cherty appearance, as a quartz-porphyry, or as a quartz-felspar-porphyry. Three masses were mapped, one containing the Ironclad, Consols, Proprietary, and associated lodes, another lying to the north-west of New Chum Hill, and still another lying northwards of the Alpine Reefs.

The occurrences are peculiar. In two cases they form hill features, the Ironclad and Adelaide Hills being quite local landmarks. Only the upper portions of these hills, however, are composed of the siliceous porphyries, the lower slopes to the south and west consisting in the main of tuffs, with minor developments of less siliceous lavas. To the north, east, and south-east the main rock types are andesites, trachytes, and dolerites with pitchstones.

Even among the siliceous rock-types under consideration, there occur patches of fine-grained tuffs, andesitic in nature, as also types suggestive of sediments. Strong dykes of andesitic type occur in the neighbourhood of the Ironclad Hill, as also of gabbro to the north.

No good natural sections of these felsites were seen, and thus the relations between them and the associated lavas and sediments were not ascertained. The general appearance of the felsites, with their associated breccias and tuffs, and their position with regard to the surrounding lavas and sediments, as also the peculiar and irregular disposition throughout their main mass of auriferous veins, and the general introduction of pyrites into the mass at various points, suggest that these felsites and quartz-felspar-porphyries are of the nature of small volcanic cones, but whether contemporaneous with, intrusive into, or a denuded inlier of, the surrounding lavas and sediments, it has been found impossible to determine upon the evidence.

Certain forms occurring in the andesites and trachytes present the appearance of felsite intrusions, but upon closer examination, it is highly probable that they simply represent alterations of the relatively basic lavas along zones of weakness containing silica and pyrites in solution. This phenomenon occurs also in the siliceous felsites and porphyries themselves. The term "dykes" is applied locally to these peculiar forms of altered rock. They admit, however, of ready separation from the true felsites, inasmuch as they are not tough, like the true felsites, but break readily with a sub-conchoidal fracture, and with the production of a clashing sound like that of breaking porcelain or glass. Moreover, they have an appearance more glassy than the unaltered felsites, and they are studded with crystals of iron pyrites.

Granites.—Two occurrences were noted, one as a small mass, elliptical in plan, in portions 188 and 274, parish Cargo. The associated rocks appear to be altered andesites, suggestive of lamprophyres in places. The texture is fine, and the felspar is reddish in colour. No porphyritic development was noted.

Loose blocks of granophyre were also found within the township of Cargo itself. The relations of these holocrystalline types to the lavas and tuffs was not ascertained.

Trachytes, Andesites, Dolerites, and Gabbros.

Trachytes.—Rocks of this type occur at New Chum Hill. On the western aspect of the hill jasperoids and other finely-textured rocks appear to dip gently towards the east. Certain members of the trachytes, such as those

forming the upper portion of the peculiar dome, constituting the elevation known as the New Chum Hill, appear to be holocrystalline and syenitic in nature; it is possible that the occurrence may be of the nature of a volcanic plug, or an inlier of eroded trachyte. This rock, when traversed by the solutions already mentioned, carrying silica and pyrites, has the general appearance of felsite.

Andesites.—These appear to consist of lavas of various types, all much altered. Certain dykes also appear to be of andesitic nature.

No. 1. *The Andesite Porphyry.*—This is a well-marked type, possessing a dark-greenish base, in which occur abundant interpenetration twins of felspar. Many alteration products, such as epidote, are found throughout the rock. It is of widespread occurrence, forming the greater portion of the rocks indicated on the north-eastern, eastern, and south-eastern portion of the map. It is probable that this is a portion of the widespread andesitic type which occurs at Mandurama, Carcoar, and other localities.

No. 2.—A non-porphyritic andesite of fine texture and of a dark-green to black colour. This forms the main rock mass in the north-west portion of the mapped area. The soil derived from it, as also that from the andesite porphyry, is of excellent quality for agricultural purposes.

No. 3.—This includes a rock type which has a great development in the southern portion of the area mapped. It has been placed provisionally among the andesites, but the specimens secured during the survey were so decomposed that no satisfactory determination of the rock has been made.

The texture is fine, the colour greenish, and much alteration appears to have taken place in the rock. In certain places the rock appears to be of the nature of pitchstone, as, for example, to the south-east of Cargo.

No. 4.—Certain other types occurring in the northern portion of the area mapped have the appearance, in places, of amygdaloidal lavas. These types also are altered, and have a very fine texture with rare development of porphyritic constituents. From their general appearance, and the soil derived from their decomposition, these types have been classed as altered andesites or allied forms. Under the microscope they are somewhat suggestive of lamprophyres.

All four types appear to be lavas. Associated with them are allied tuffs.

No. 5.—The peculiar dyke with which the Ironclad Lode is intimately associated has a dark base of fine texture, with a strong porphyritic development of felspar. Porphyritic quartz is also present, as also hornblende and other minerals, recorded by Mr. W. Anderson. Although this rock is classed here as quartz-felspar-porphyry, care should be taken not to confuse it with typical felsites, rhyolites, and other siliceous rocks, as it appears to have greater affinities with the andesites than with the siliceous types.

Dolerites and other Basic Types.—These consist of dykes traversing the andesites and tuffs. One strongly defined dyke occurs in the andesite porphyry, about 1 mile along the Orange-road. This, apparently, has a great development of hornblende, and is a gabbro-porphyry. The rock is decomposed. Another wide dyke of dolerite occurs in the Gerybong Creek, at Cargo. The intruded rock is the "andesite porphyry." Other powerful dykes of dolerite occur both in Copper Gully and near the Essex Mine. Most of these basic types have a fresh appearance.

The rocks have been named by Mr. G. W. Card, A.R.S.M., Curator and Mineralogist, from thin slices, prepared for microscopical examination.

Geological History of Region.

The Ordovician appears to have been characterised by fairly deep sea conditions. Should the auriferous area of Cargo be found, hereafter, to be of Ordovician age, then volcanic action is also strongly suggested for this period. A movement of intense compression closed the period and ushered in the Silurian, and the sea gradually transgressed the newly-formed land, partly by the attack of the waves, but, in greater measure, by the sinking of the land. A rough shore line existed to the west, where the present township of Forbes now stands, and stretched thence to the northward for a distance of many miles towards Parkes. This feature may have been merely local, a large island strand possibly, nevertheless coarse conglomerates of great extent are to be found in the western portion of the county, the pebbles consisting of plutonic rock fragments of various descriptions, while the shallow waters in this zone teemed with life, consisting of corals, brachiopods, and others forms. Large fragments of Halysites, at times, form part of the conglomerates. In the Cargo area itself masses of limestone were deposited in thin and well-defined layers, both in the intervals, while the volcanoes of the adjoining islands or mainland were quiescent, and while they were in an actual state of eruption at times. In short, the Cargo district at that period must have presented striking analogies to the phenomena to be seen to-day around the larger islands of the Pacific or Indian Ocean, where reef limestones are in process of formation upon the subsiding masses of tuffs, limestones, and other sediments, the volcanoes on the adjoining lands at the same time being in a state of intermittent activity. The absence of fossils in so many of the blue limestones of the large district under consideration does not at all imply, necessarily, that animal life was rare at those spots during the formation of the limestones, for the greater portion by far of the "reef rock" forming so much of present-day "coral reefs" consists of solid, homogeneous limestone, apparently devoid of organic remains.

Submarine volcanoes appear to have played an important part in the formation of the landscape, while large land areas existed also in the vicinity from which great beds of sediment were derived. Local deeps may have existed in the area, as suggested by the presence of the claystones.

This eventful period was closed by a strong compressive movement, which crumpled the sediments laid down in the warm, but troubled waters of the Silurian. Mountains were formed, which, in turn, were worn down both by the streams and the waves, aided by subsidence. Conglomerates were formed probably, in great measure, from the loose material worked over by the waves of the transgressive Devonian sea. Conditions partly marine and partly continental (lacustrine or fluviatile) are indicated for the area. Great thicknesses of quartzite were formed in thin and well-marked layers, while sandstones and shales were sandwiched in, all suggestive of deposition in shallow water. Heavy volcanic action must have been in progress on the associated lands, as indicated by the great aggregate thickness of chocolate, greenish, and grey, sediments of tuffaceous origin.

The Devonian sedimentation in this district was closed, as the Silurian before it, by a compressive movement. The Ordovician had been powerfully crumpled and altered, the Silurian also strongly folded, but without the same marked effects of compression as those exhibited by the Ordovician sediments. The Devonian, however, in County Ashburnham, has not been folded to the same extent as the earlier Palæozoic sediments. In the western portions of the county, as ascertained during a traverse from a point 20 miles west to one 20 miles east of Forbes, the dips of the Devonian

rarely exceed 20 degrees, while in the Cargo area they are characteristically steep, being almost vertical in places.* Whatever stress, therefore, had been applied to the eastern members of the series, for some reason, appeared to have died out, in great measure, towards the western portion of the county.

During the closing Palæozoic and the succeeding Mesozoic periods, the area under consideration appears to have had an uneventful history. Slight, vertical movements, with slow denudation, is an epitome of its history during this long period.

The great surface of erosion, which was the work of Mesozoic action, was elevated in the Tertiary, and the streams of the Lachlan then commenced to cut a shallow and very wide valley out of the rising ground. The elevation of the region proceeded intermittently, while the intervening periods of stable equilibrium and stream erosion were of great duration. This appears to have been the work of the earlier Tertiary, and the great lesson of the Tertiary movements in this district is the slow and intermittent nature of the uplifts which culminated in the formation of the high plateaus, only after long, intervening periods of erosion.

In connection with this subject it is instructive to note that river wash is to be found on almost every surface of erosion. The hills, rising to heights of about 300 or 400 feet above the Cargo township, and lying about 500 or 600 feet lower than Orange, evidently mark the level of one of these valley floors, and the numerous patches of river wash on the same hills mark the traces of old stream courses of that period. This valley floor appears to be from 20 to 25 miles in width, and after its formation the basalts which buried the Forest Reefs leads of the plateau appear to have flowed down the valley sides for many miles, burying the country from Orange to Cudal, and thence south to Bowan Park, and towards Cargo. Subsequently the land rose in stages for about 2,000 feet, and the deep gorges of the Lachlan system were excavated in the rising ground; nevertheless, so slow and intermittent was the movement that the main rivers in the harder country do not appear to have been deflected in any marked degree, inasmuch as the great valleys already mentioned appear to have been excavated one within the other. Although this is true in general, nevertheless there were numberless deviations of a minor nature from this rule, by reason partly of the basaltic outpourings, and by reason partly of ordinary stream action. Thus, after the outpouring of the basalts which preceded the Canoblas outburst, the streams again excavated wide valleys within the Cargo level, and at a still later period the Gum Flat stream cut a deep gorge into both the limestones and associated rock types, leaving the ridge between it and the present Cargo as a high escarpment at least 800 to 900 feet in height. From its headwaters, which were located, apparently, in the dense Devonian quartzites and the hard Silurian tuffs a few miles to the east of Cargo, this stream worked its way into Gum Flat, apparently from the north, around the steep and high ridge of lavas and sediments.

After this period of active cutting the streams appear to have filled up their old channels, for great depths, with waste. To such an extent was this alluviation carried out that the old, steep escarpment separating Gum Flat from Cargo was reduced in height by about 400 or 500 feet. That is to say, alluviation to the extent of from 400 to 500 feet is suggested for this valley. After the filling of the deep valleys a change took place in the local topography, for whereas the old Gum Flat drainage had headed back for many

* See, however, "Note on the Silurian and Devonian Rocks," by C. A. Sussmilch, Proc. Roy. Soc. N.S.W., 1906, Vol. XL, pp. 130-141, and Pl. XIX. In Mr. Sussmilch's section the Devonian is shown forming a local syncline, possessing no dips of high value.

miles into the dense Devonian rocks, it now has a run of about 2 miles only above the Cargo-Canowindra-road at Gum Flat. Evidently a new divide has been set up somewhere in the newer river alluvium itself, and a reversal of the old drainage in part has taken place, one portion now flowing down Cargo Creek, the other flowing north-west from the new divide. By this action the alluvium has been denuded probably to the extent of from 100 to 200 feet, leaving a capping from 300 to 400 feet in thickness of drift over the leads.

At a later period "shallow" runs of alluvial wash were formed upon this surface, while during a still later period the alluvium has been again strongly denuded, the present Cargo Creek having cut its way almost 100 feet into the alluvium, not in the nature of a deep gulch, but as a wide valley with walls of gentle slope.

MINING GEOLOGY.

(*a*) Alluvial Deposits.
(*b*) "Lodes" or "Reefs."

(*a*) *Alluvial Deposits.*—These may be divided into deep and shallow "leads."

(1) *Shallow Leads.*—Deposits of this class fall into two groups, namely, surface drifts and stream-wash buried to depths not exceeding 100 feet. Most of the short gullies which head in the auriferous country of the Ironclad Range contain gold, and these have all been worked towards Gerybong Creek, on the one hand, and to Gum Flat, on the other. The most important of these were the Long, Township, Graveyard, Scrape Rock, Tin Dish, and Copper Gullies.

By following the shallow deposits of such of these gullies discharging towards Gum Flat the ground was observed to get deeper, the workings being as much as 30 feet deep on the edge of the alluvium of Gum Flat. Thence to depths of 50 feet the workings were continued, at which level the gold was considered to have disappeared. The bottom upon which the gold was found, however, was observed to be of false nature, and, at depths less than 100 feet, a deposit of wash was found with high, but varying dip.

(2) *Deep Leads.*—The nature of this group of deep drifts has never been satisfactorily explained. From statements supplied by old miners, who, however, in turn, have only received their information second-hand, a mental picture is afforded of a deep, wide valley, now filled, in great measure, with river material, which has a steep gutter as yet not located, but which, if found, would be decidedly auriferous. Continuing the construction of this mental picture, a steeply-pitching, indeed, almost vertical lode, or bank, of auriferous wash would be seen clinging to the hillside, and which, if only persistently followed, would lead to the hypothecated gutter lying farther out in the valley. This steep creek would not be exposed at the present land surface, but would be covered, in part, by the alluvium of the main valley to depths vaying from fifty to one hundred feet. In part also it would be covered by wide and thick beds of coarse gold-bearing stream drifts, which dipped away gently from the hillside and died away to a feather-edge at variable distances towards the valley centre.

On the other hand, the official statements, meagre though they are, and while bearing out the statements of the miners in great measure, nevertheless do not agree with them in detail.

For example, these official reports indicate that the "lode" is of irregular form, being at times practically absent, and they indicate, moreover, that

some determined efforts were made on different occasions, as in 1904, in 1878, and in the period prior to 1875, to locate the deep gutter of the lead, supposed to be auriferous, with only disappointing results.

Thus, in 1878, the Cargo Prospecting Association made an application to the Prospecting Board for aid, to the extent of £300, for the purpose of sinking a deep shaft to test the Gum Flat gold drifts [Prospecting Papers, 78/4985]. The Committee, in their application, stated: "We are also directed to inform you that no shaft has as yet been bottomed where they propose to sink. That on the south end of the flat a shaft has been sunk to a depth of 315 feet, one 219 feet, one 333 feet, and on the northern end a shaft 270 feet, the distance from the extreme southern shaft to the northern shaft being fully 1½ miles, none of the above mentioned shafts have been bottomed."

The results of the aided tests and the opinions of those who examined the workings are mentioned in the Prospecting Board papers dealing with this and subsequent applications for aid. These have been summarised by Mr. J. E. Carne, Assistant Government Geologist, in Prospecting Board papers 04/3351, and are here reproduced:—

> "The application [of 1904] is apparently based upon a paragraph in the late Government Geologist's report for 1878 (vide Annual Report, Department Mines, 1878, p. 152), to the following effect:—
>
> "We may therefore expect to find here two sets of deep leads, the upper one of which, with the black clays and fossil leaves, will be found resting in places in the older rounded quartz pebble drift, and this latter will rest on Silurian schists and limestones. An almost vertical vein of alluvial wash has been followed to a considerable depth. The unusual position of such wash induced some persons to regard the so-called vein as a fissure leading to some subterranean passage in the limestone beneath the older drift, but I rather regard this wash as not having filled up a fissure, but as having been the surfacing on the side of the valley in the Pliocene times, and before the valley was filled in by the subsequent deposits. This vein should be followed down, as it will eventually lead to the bottom of the old valley, and consequently to the bed of the old watercourse or lead."

"This opinion is cited," writes Mr. Carne, "in opposition to views expressed by the late Chief Inspector of Mines in a letter dated 21st January, 1901, that caverns in the limestone, and not a lead, existed. Mr. Slee's statement was based on subsequent prospecting, of which applicants are presumably unaware."

It might here be noted that Mr. Wilkinson evidently overlooked the angle of slope when regarding the "almost vertical vein of alluvial wash" as *surfacing* on the side of an old valley.

From the records it is evident that the supposed deep channel at Gum Flat received early and practical attention. As far back as 1878, out of a vote of £5,000 for the whole State, it received prospecting aid to the extent of £487 10s., the whole being expended in three shafts and considerable driving, after the locality had been inspected by Mr. H. Wood, Under Secretary, Mr. C. S. Wilkinson, Government Geologist, Mr. Slee, Inspector of Mines, and Mr. Dalton, Warden.

Mr. Slee states [P.B. papers, 01/3045] that since the above test three parties have been aided lower down the Flat with like negative results.

The 1878 test was a very practical and effective one—the local miners and others interested binding themselves under a bond to carry out their part. The site upon which to sink was selected from the indications furnished by the then deepest shaft—over 300 feet. The shaft was sunk to a depth of 370 feet on to a limestone bottom without wash.

Driving along the apparent dip of the bottom a limestone wall was encountered. Starting from 334 feet level, it was again met with. Mr. Slee, after inspecting the work, reported in favour of abandoning the shaft in the following terms:—"After careful examination I endorse the opinion of the prospectors that it would be useless to work any longer in this shaft; there is no doubt the shaft has been sunk between high walls of limestone, the cavern being filled up with alluvial strata." Another shaft was subsequently bottomed at 54 feet, about 200 yards north-east from No. 1 with gold prospecting about 2 grs. to the dish on a granite bottom. A third shaft was then started about 70 yards south of No. 2 (towards No. 1). No. 3 shaft bottomed on slate at 190 feet, with only a colour of gold. A drive was extended in the direction of dip, that is, between the two last shafts; from it a winze was sunk 70 feet on to granite, but not even a colour was raised.

The work was thereupon abandoned, the local miners being satisfied with the tests made.

In connection with the deep lead, or leads, of Cargo, the main facts disclosed, as a result of the present survey and the literature quoted above, appear to be somewhat as follows:—

The working of the shallow leads heading in the Ironclad Range led to the exploitation of the "made" ground to a depth of nearly 100 feet from the present surface.

The auriferous drifts thus worked revealed the presence of outwash deposits of irregular shape.

Beneath these deposits of gentle profile a steeply-inclined mass of auriferous material was worked, the footwall of which, to employ a "reef-mining" term, being formed of bed rock, such as limestone, lava, or so-called "granite," while on the hanging-wall side these drifts passed mainly into a ferruginous sand.

Mingled with these deposits, or in a layer beneath them, many boulders of Devonian quartzite were found, these not having been found *in situ* within the present catchment.

These quartzite boulders are well rounded and appear to have travelled a considerable distance. The majority of the wash, however, which was raised from the deep shafts and workings was subangular to angular in nature and of such an appearance, generally, as to suggest its local origin.

The deep ground has been traced for about a mile, but the gold values were patchy, being confined, apparently, to the vicinity of places at which the Copper, Durwood, and associated gullies empty themselves into Gum Flat.

Shafts sunk further out towards the centre of the old valley have yielded no gold drifts.

The profiles of the hillside forming the so-called footwall of the "lode" are variable, being much steeper in certain places than at others.

In the deep tests carried out in 1878, under aid from the Prospecting Board, a steep channel with limestone walls was encountered at least 50 feet in depth.

This old lead must have had connection with some other valley, now separated from it by thick masses of river drift and outwash, the result of the aggradation or alluviation of the old channels.

Combining these facts the sequence of events in the formation of the leads appears to have been as follows:—

Deep and steep-sided channels were formed in the Cargo area at a certain period, and the path taken by the main stream was probably steep. The catchment was considerable, and the river drift was large and often well rounded. No gold reefs of commercial importance have been recorded in the vicinity of the Cargo locality, hence the main channel could not be expected to possess auriferous drifts of economic importance except at points where it could be enriched by local feeders. The case of the Eucumbene at Kiandra is an illustration of this principle. Here the river was payable as it traversed the narrow gold belt, but it became unremunerative immediately below that belt. The Eucumbene at Kiandra is practically at its head, but had the river here possessed a large catchment area as compared with that of the gold belt at Kiandra, it is doubtful whether, even at this spot, it would have contained payable alluvial deposits because its valley drifts would have been many times greater than at present, thus yielding a much less proportion of gold contents.

The leads of Parkes and Forbes afford still another striking illustration of this principle. In the latter locality the shallow leads were rich at their heads, but lost their economic value almost as soon as the streams had once crossed the gold belt.

These peculiar geographical conditions came to an end at a time when, for some reason, the excavation of the deep gorges was brought to a close and the process of filling the same commenced. The alluviation of the old channels may have been caused by the blocking of the stream along its lower course, or by the outpouring of lavas, or again by faulting or warping, or even by other action such as decreased precipitation. Of blocking by lavas of the stream courses, or by faulting, there is no direct evidence, and it is probable that the alluviation was caused either by a warping movement or one of irregular subsidence, by the decrease of stream action attendant on a decreasing rainfall, or again by the mature dissection of the hinterland. But by whatever cause accomplished, the formation of the Gum Flat Lead was initiated, and gradually the deep ravine forming the lower portion of the Gum Flat Valley, under the western slopes of the Ironclad Range, became filled with material brought down in great measure from the divide at its head. This material, for reasons already set forth, would contain little or no gold contents.

The velocity of the stream would thus gradually decrease; its transporting power would be considerably lessened; and the stream channels would be gradually filled with the debris derived from the hills of the catchment. Under certain conditions the whole stream channel might be gradually filled with debris. But since the stream power at this stage would have diminished to such a degree, the beds of material filling the channel would not be so coarse as the material nearer the base. This of course is on the assumption of an unaltered average rainfall. Coarse debris might still occur in the channel nearer to its head, but at this stage it would not be carried as far down the channel as formerly; so that above the coarse bottom beds, material less coarse in texture might be expected to occur.

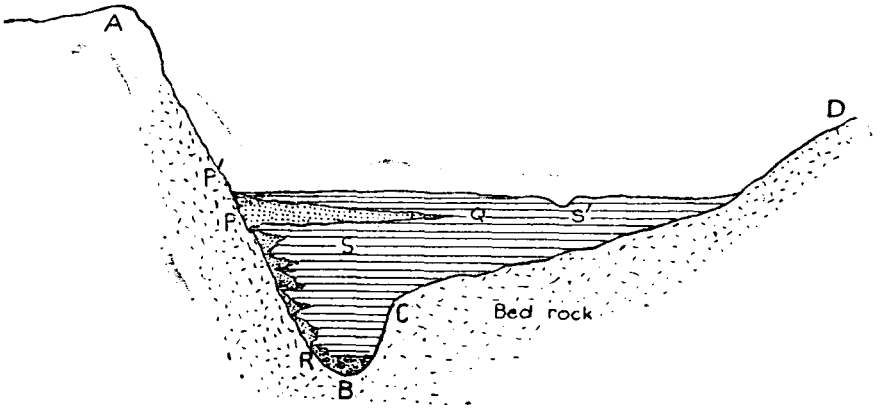
Among such beds of finer texture might be mentioned sand, grit, clay, or even impure carbonaceous material such as lignite.

In the meantime the outwash from the short, steep gullies draining the western portion of the auriferous belt would be piled upon the western slopes of the Ironclad Range. In this connection it must not be forgotten

that, both in Australia and other countries, steep cones of outwash are piled up at the mouths of gullies, where they deploy on to flats at the bases of steep hillsides. These are the result of periodic furious storms, or "cloudbursts." It should not be forgotten also that the slope of the Ironclad Range was steep, but variable, being almost perpendicular in places. Thus, while the valley proper was being slowly, but surely silted up, the local storms on the Ironclad Range would pile up heavy alluvial fans or cones of outwash material containing gold derived from the reefs in the range. The footwall to this outwash would be the hillside, while the width of the wash itself might be very variable owing to the differential action of storms on the western side of the Ironclad Range.

The outwash would remain close to the hillside because the silt of the main channel brought down from the whole catchment would form a support to it and thus prevent its removal far into the valley. Moreover, seeing that the main channel was also being *silted up* with material of moderate to fine texture only, there would be but little likelihood of the local outwash from the Ironclad Range being swept down the main valley by the weakened stream. The footwall of the outwash would thus be the actual slope of the hillside, but the hanging-wall aspect would have a less steeply-pitching dip to the valley, owing to the slope of repose set up by, or among, the fragments. The outwash would thus form a series of imbricated or overlapping cones, having a steep footwall but a very irregular "hanging-wall," where it became sandwiched into the alluvium of the valley.

With progress of time the silting action along the main stream became checked or completed. Nevertheless the outwash was still poured out into the alluvium. With each succeeding storm or "cloudburst" the material



was carried farther out into the valley, and the profile of the alluvial fan thus formed would become much flattened. The accompanying diagram illustrates the general sequence of events in the locality. ABCD may be considered as a cross-section of a deep and steep-sided gully. At B is represented the coarse wash of the main stream at a period when the erosive action was vigorous. PR represents the outwash from the hillside AB and SS′ the sands, grits, and clays resulting from the general silting action of the main stream. PR is of variable width, as shown in the diagram representing the irregular action of local and general aggradation.

P'Q represents the spreading out of the outwash at a period when the general alluviation had received a decided check.

The slope of the bedrock would be variable, being as much as 80 or 90 degrees to the horizon alongside cliffs, while the actual path taken by the outwash from the escarpment would rarely exceed 50 or 60 degrees unless the small hillside creeks discharged over waterfalls into the main valley.*

This all leads up to the main consideration, namely, the chance of finding payable gold in the main "gutter" of the valley, especially at points up-stream and down-stream from the auriferous belt of the Ironclad Range. It is a well known fact that auriferous deposits of commercial importance are of rare occurrence in, if not indeed absent from the district, except at Cargo itself. Furthermore, it is highly probable that the present catchment area of the upper portion of Cargo Creek is very small compared to that drained by its immediate ancestor. In the first place the gold contents, if any, of the main channel can only be reasonably supposed to have been derived from the Ironclad Range. In the second place the great disparity in area of the golden belt and the catchment of the stream would reduce the proportion of gold to barren drift in a marked manner. In the third place, gold is of high specific gravity and soon falls out of the current. In general, when the stream is small, and its channel is of gentle slope, the gold does not appear to be carried far below the vein or lode from which it has been derived. Thus, if channels of this description traverse gold reefs, they will be continually enriched, but the influence of such enrichment will die away rapidly with progress down-stream. This is well exemplified by the Parkes, Forbes, Kiandra, and other streams.

An application of these principles would suggest that the Ironclad Range supplied the gold which has been found in Gum Flat, that storm-waters in the steep gullies leading therefrom carried rich gold contents on to the flat, but that at such point they lost their power, and hence, also their efficiency as gold carriers. The chance of obtaining payable gold, therefore, from deep "gutters" farther out in the Gum Flat Valley is limited. The same reasoning applies to the case of the deep lead in its course both above and below the gold belt.

The following extracts from the departmental publications concerning the alluvial mining at Gum Flat should be of interest:—

> "During the year 1878 about 3,200 loads of wash-dirt were treated from the claims at Gum Flat, and about 730 oz. of gold obtained."
>
> "In 1880 some 1,500 loads were treated for a yield of about 250 oz. of gold, or a little over 3 dwt. to the load."
>
> "In 1881 Odgers and party got a shallower ledge in the claim, in which they have been at work for the last nine years. The wash-dirt is from 6 inches to 2 feet wide, and yields about 10 dwt. to the load. About 1,000 loads from the Gum Flat workings have been treated, and yielded some 350 oz. of gold, or about 7 dwt. to the load."
>
> "During 1882 Odgers and party washed 500 loads, from which they obtained 200 oz. of gold. In their claim a lode has been worked from a depth of 40 feet to a depth of 350 feet, at which level it became poor and narrow. Further prospecting at the 40 feet level revealed what may be called a feeder to the main lode. This deposit is 70 feet wide and 18 inches deep."

* Several geologists have suggested to the authors the possibility of faulting, or sharp-tilting (of a layer of drift once horizontal), to account for the peculiar appearance of the "lode" wash. This idea had suggested itself also to the authors in the field, but did not appear to be the explanation, because, despite the fact that the "lode" wash is of recent geological age, there is no topographic evidence of faulting, nor of folding, in the Cargo locality, the general appearance and arrangement of the valleys being such as to suggest the action of long-continued denudation in this district.

"In 1883 1,000 loads were treated for a return of 3 dwt. to the load, or a gross yield of 150 oz. of gold. Odgers and party were on a good patch at the beginning of the year, but it soon cut out."

"In 1884 about twelve men were engaged fossicking in the old workings at Gum Flat. They washed about 300 loads, which yielded about 3 dwt. to the load, or a gross return of 45 oz. of gold."

"Some 30 oz. of gold were obtained from the alluvial workings during the year 1888."

"During 1904 a revival in mining took place at Gum Flat. As a result of a discovery by Hennessy, Hamilton, and party, some forty or fifty men were engaged in alluvial mining. The prospectors bottomed a shaft at a depth of 100 feet, and proved the wash to be from 18 inches to 20 inches in thickness, and about 30 feet in width. Dish prospects were high, and some nine loads of dirt treated gave a return of 9 oz. 7 dwt. of gold. Mobbs and party, north of, and adjoining the prospectors, bottomed at 125 feet on what is said to be the "top wash." No other parties, were, however, successful in striking payable wash. The deepest shaft was that of Thompson and party, on the south end of the field, which was sunk 250 feet, and not bottomed."

"In 1905 some 324 loads of wash-dirt were raised and treated for a yield of 150 oz. of gold."

"During 1906 thirty loads were treated for a yield of 5 oz. 6 dwt., valued at £19 7s. 6d."

"M. Hennessy treated forty-five loads for 14 oz. of gold, valued at £49 during the year 1908."

"In 1911 casual fossicking was done, and 10 oz. of gold valued at £39 obtained."

"In 1912 a little fossicking was done, only 5 oz. of gold, valued at £19, was produced."

(*b*) *"Lodes" or "Reefs."*—The ore deposits of Cargo are not of the nature of true reefs or lodes, that is, they are not tabular in form with well-defined walls. On the contrary, they consist, in the main, of narrow zones of country of irregular shape, which have been formed by the introduction of silica, sulphur, iron, and other solutions along dykes of peculiar nature. In a few instances these zones of "mineralisation," as they are commonly called, altered the country by attacking it along a number of netted veinlets. Free silica, as quartz, is conspicuous by reason of its absence, and so-called "reefs" are of the nature of irregular impregnations, which are difficult to follow by reason of the relative absence of definite mineral veins such as quartz.

The auriferous belt itself, in which the veins are contained, is of limited area, being somewhat triangular in plan, the apex pointing to the north-west and lying in the neighbourhood of the Commonwealth and Mobbs' reefs, while its base contains the Essex, Dalcoath, and Proprietary lodes. The orientation of the triangular area is approximately north-west and south-east. Its longer axis is about 2¼ miles in length, and its maximum width is about a mile and a quarter.

Although the auriferous area has a north-west and south-east arrangement, nevertheless the strikes of the reefs or lodes themselves rarely conform to this direction. On the other hand, the main lines of reef such as the Ironclad, the Dalcoath, the Rowe's line, the Rise and Shine, and the Alpine lodes possess strikes approximately varying from north 10°-40° east and south

10°-40° west. The Essex is a type possessing a strike almost east and west, while the Commonwealth, Mobbs', and Gazzard's lodes have strikes approximately north-west and south-east, or that of the gold belt itself. In connection with this general trend of the auriferous belt to the north-west and south-east it is interesting to note the occurrence of rock alteration in places along north-west and south-east lines. The zones affected are of very variable width, and are termed "dykes" by the local miners. They are supposed to be "dykes" of felsite, in which a proportion of copper, iron pyrites, and gold occurs. In reality, they appear to owe their origin to the introduction of silica, sulphur, iron, and other elements along joints, or zones, which possess the same general trend as that of the gold belt. On the other hand alteration, such as that here considered, has affected the rocks in variable degree, so as to produce discontinuous or interrupted lines with local increase in width, as at the Ironclad Mine, and at other places.

With respect to the variable appearance and strikes of the ore deposits at Cargo it would appear that the north-east and south-west veins, such as the Ironclad, are intimately related to the intrusion of dykes of variable composition, while the netted-vein or impregnation systems may be referred to the action of expiring vulcanism. Thus the north-east and south-west system is at times associated with dykes, as at the Ironclad Mine, and the veins of such a system occur indifferently in felsites, in tuffs, in quartz-felspar porphyries, and in lavas of andesitic or more basic nature. The deposits of irregular shape, however, as at the Proprietary Mine and Copper Gully, are confined in the main to the felsites and quartz-felspar porphyries, and fall into the second group of ore deposits. This would necessitate a crater or "pipe" origin for the siliceous porphyries, an assumption supported by other evidence, such as the presence of coarse breccias, fine examples of which occur at Copper Gully, and the marked variations in the appearance of the felsites and siliceous porphyries indicated on the map.

This would indicate a double age for the gold deposits, the earlier being due to the action of decadent vulcanism, the later to the intrusion of a series of dykes, andesitic to doleritic in nature, and younger than the lavas and tuffs.

Another peculiarity of the lodes, or impregnations, is the decided influence the wandering solutions, which formed such deposits, have had on the country. Thus the zones of altered felsite, known as "dykes" by the mining community, are characterised by their cherty appearance, their sub-conchoidal fracture, their relative brittleness, and the decided development within them of iron pyrites. In the trachytic rocks of New Chum Hill, the so-called "felsite dykes" are simply alteration products (with bleaching) of the trachyte, by the introduction of silica, sulphur, iron, and other elements. Some of the more basic material may have been leached out at the same time.

In the Cargo reefs, as in those of many other portions of the State, the payable ore appears to have been limited to lenticular patches arranged along the zones of alteration.

This irregular disposition of the pay-ore, together with the intimate association of the gold contents with the pyrites, has been responsible for the difficulty experienced in the economic working of the Cargo Mines.

The distribution of the pyrites through the ore is peculiar, being sometimes in aggregates, but most frequently as isolated cubes somewhat like crystals in a porphyry.

The depth of water-level is unknown, and the pyrites, in places, outcrops at the surface. In certain lodes a considerable amount of leaching of the pyrites has taken place near the surface. This imparts a cellular appearance to the rock thus leached. Certain specimens from the Consols Mine exhibiting such removal of iron pyrites possess a specific gravity very little greater than that of water.

Our attention was drawn to several small outcrops of ironstone, which are considered to be a line of lode of importance on the field. The ironstone outcrops as small isolated patches, some distance apart, and there appears to be no reason for assuming that they are either connected below the surface, or arranged along any definite line or junction of geological formation. Very little work has been done on any of the occurrences to ascertain the value of the ore, which could only be proved by systematic prospecting and sampling.

The following concise and interesting report on this field by Mr. W. Anderson, Geological Surveyor, in the year 1890, is here reproduced:—

"From Orange to about a mile past the Half-way House the road passes over the andesitic lavas, which were, in Tertiary times, erupted from the hills in the neighbourhood of Orange, known as the Canoblas. These lavas are followed by a belt of Silurian slates, which within 4 miles of Cargo are overlaid by another lava sheet 3 miles in width. The immediate vicinity of Cargo is occupied by an intrusive mass of quartz—porphyry and felsite, which has intruded the slates in a more or less north and south direction. In connection with this intrusive rock numerous auriferous pyrites reefs occur, some of which are of a persistent character, and have been extensively worked."

"As exhibited in the sections exposed in the workings of the Ironclad and other mines at Cargo, the intrusive rock is of a very variable character. In places, where slightly weathered, particularly in close relation to the western side of the Ironclad Lode, it is a nodular or bouldery felsite and quartz-porphyry, of a greyish colour, and bearing a remarkable resemblance in its general appearance to the felsites and quartz porphyries which occur in connection with the silver bearing lodes at Sunny Corner. Along with these nodular felsites and porphyries other eruptive rocks occur, which are more or less allied to the former. A detailed description of these rocks will be furnished in course of time in a separate paper. The majority of these lodes opened up in the neighbourhood are in connection with these intrusive rocks."

"The principal mine, and that upon which most work has been done, is known as the Ironclad. It is situated close to the town, on the hill upon the slopes of which the township is built. It is now a number of years since the mine was first opened up, and the underground workings are of considerable extent. The outcrop of the lode has been traced in a generally north-east and south-west direction for a considerable distance, and numerous shafts have been sunk upon it, the deepest of which attains a depth of 470 feet. For the first 200 feet the lode is nearly vertical, and below this depth its average dip is 65° in a south-easterly direction. It chiefly consists of iron and copper pyrites, and varies in thickness from a few inches to over a foot, but it has been proved to be persistent to nearly 500 feet. The foot-wall consists of a light coloured quartz-porphyry, which in places is a non-porphyritic felsite, and possesses a nodular structure where in contact with the

lode. This is no doubt due to the ready decomposition which the rock undergoes along that line. The hanging wall is formed of a porphyritic rock, containing microscopic crystals of hornblende and felspar, and thereby differing from the quartz-porphyry of the foot-wall. In the neighbourhood of the lode proper, both walls are impregnated with pyrites to such an extent, that locally the width of treatable ore is largely increased beyond the actual thickness of the lode."

"The pyrites to a depth of 130 feet had undergone decomposition to such a degree, that the contained gold occurred in a free state, in the position of the lode and its immediate vicinity, but below that level the gold was entirely confined to the pyrites which has to be specially treated for its extraction. In places the lode consists entirely of solid iron and copper pyrites. At the 300-foot level at the northerly end of the workings the lode contains such large quantities of calcite, that it is impossible to treat this ore by itself, because of the high percentage of lime which is present. At a lower level, however, the calcite diminishes in quantity, and there is a proportionate increase in the cupriferous ore, and according to the experience of the manager, Mr. Marsh, in other parts of the lode, wherever the percentage of copper ore was large, there was an appreciable increase in the yield of gold from the ore, particularly if the copper existed in the form of the black oxide. At present there are considerable bodies of the iron and copper pyritous ore in sight, and there is every probability that the lode will be found to persist to a depth, but it is likely to be very variable in thickness."

"From the difference in the character of the two rocks which forms its walls, it would seem as if the lode had originated in a contact fissure, and that the porphyritic hanging-wall rock had been subsequently intruded into the quartz porphyry and felsite, in the form of a dyke, on the western side of which the Ironclad lode occurs. It is very probable that there may be, at the eastern edge of this dyke, where it joins the quartz-porphyry, pyritous lode stuff which might be worth prospecting for gold. This eastern line of junction must occur between the present Ironclad lode and the road from Cargo to Canowindra, because on the easterly side of this road the hills consist entirely of the light-coloured quartz-porphyry which is almost destitute of hornblende and is evidently the same rock which forms the foot-wall of the Ironclad lode."

"On the hills to the north-west of the Ironclad numerous parties have at one time and another sunk numbers of shafts on small leaders which however have not proved of sufficient width or thickness to encourage them to proceed to any depth with them. One of these claims is known as the Golden Clad, which consists of thin veins of gossan (decomposed pyrites) which have been sunk upon to a depth of 60 feet. Crushings from this claim are reported to have gone about one ounce to the ton, but the veins are so thin that the expense of getting out the ore in sufficient bulk would be too great to work the vein by itself. The same party have, however, another claim on the south-east of the Cargo and Canowindra-road in which there is a considerable bulk of surface stone which on assay yields a few dwts. per ton, and which the party purpose to treat with the Golden Clad stone. In the claim referred to, on the south-east of the road, there are no evidences of reefs or lodes, but the quartz-porphyry has local areas in it which almost entirely consist of ferruginous gossan carrying a little gold. These areas have

no doubt been originally occupied by iron pyrites which, by segregation, have formed specialised areas, the pyrites in which has subsequently undergone decomposition, leaving a siliceous gossan containing a small percentage of free gold. One such patch of gossan has already been opened out and appears to be of considerable extent, but when they are sunk upon, if they extend below the water level the gold will be wholly confined to the undecomposed pyrites. The occurrence of these segregated patches of pyrites will be found to be very uncertain, and their individual extent will be exceedingly irregular."

"About 2 miles to the south of the Ironclad is a mine known as the Dalcoath. The outcrop of this lode runs nearly north and south, and a great deal of work has been done in the sinking of shallow shafts upon it. The deepest shaft sunk by the present party is down 130 feet on the underlay of the reef. From what I could learn, the reef was of a similar character to the Ironclad, and passes at a depth into an iron and copper-pyritous lode. In thickness it varies from a few inches to over a foot, and has, according to report, yielded good returns. As there was no one at work at the time of my visit I was unable to examine the underground workings, but from what I could gather from the rocks, which have been brought to the surface from the various shafts, the lode seems to occur among a similar set of rocks to those among which the Ironclad lode occurs. From some specimens which were picked up here it would appear as if the dyke rock was more of the nature of a dioritic or syenitic rock, consisting chiefly of altered hornblende and felspar. There is a great likelihood that this lode occurs along the junction line of the same dyke upon which the Ironclad lode occurs, although in the two positions the dyke rock presents a considerable difference in structure and composition. In both places, however, it has originally contained a large percentage of hornblende which has now been much decomposed and in places altogether replaced by chlorite. The decomposition of the hornblende in the dyke rock has, no doubt, largely increased the quantity of free gold in the lodes, particularly in the upper superficial parts, for it is a well-known fact that the ultimate analysis of hornblendes almost always produces traces of gold. From its position it is probable that it will be found like the Ironclad to be persistent to a considerable depth."

"At Paling Yards, about 8 miles from Cargo, a considerable amount of work has been done in sinking upon various reefs, which consist chiefly of auriferous pyritous quartz, carrying a little galena, and near the surface forming veins of ferruginous gossan. They occur in connection with an intrusive rock which exhibits very large porphyritic crystals of felspar, which are probably sanidine. Court's Reef varies from a few inches to a foot in thickness and dips to the west. Numerous shafts have been sunk on it to a depth of 40 to 60 feet, at which depth the lode stuff is pyritous quartz. Various bulk crushings have been made from it at different times, and the average yield has been about 15 dwt. per ton. The party are at present putting a small battery in order to begin crushing what ore-stuff has been already raised from the shafts. A few other reefs have been slightly prospected in the vicinity, but none of them to any great extent."

"The valleys formed by the drainage from the hills in the neighbourhood of Cargo, upon which the auriferous lodes occur, have all carried a fair amount of gold in their alluvial deposits. Those passing to the

south-west and west open into an extensive alluvial valley known as Gum Flat. Many efforts have been made to trace the gold-bearing drift out into this flat, but so far they have not been able to bottom upon a gutter. In one place Government aid was granted to assist in prospecting the flat, but as yet no good results have been obtained. There is no doubt that there exists here numerous old Pleistocene channels, which are likely to carry payable gold; such channels would, I think, most readily be discovered, by tracing them from among the ridges and following them outwards on to the flat."

"A few miles from Cargo, at Deep Creek, some shafts have been sunk through the Tertiary lava for the purpose of testing the presence of a deep lead underneath. Government aid was granted at this place to further prosecute the search, but the selection of sites for shafts which might strike the channel would be, from a cursory superficial examination, almost impossible. Up to the time of my visit no party had accepted the aid which had been granted to the Progress Committee to sink at Deep Creek. It is, I think, certainly probable that this run of lava covers up a Tertiary valley which must contain drift which might contain payable gold."

"Besides the mines mentioned in this report there are many others in the neighbourhood of Cargo which have been sunk upon, but never opened out."

"Taking the district as a whole, there seems every reason to believe that it may yet prove comparatively rich in minerals. The reefs at a depth seem to make into pyrites, associated with copper, which are generally gold-bearing, and there is little doubt that if opened up this would be a very important district for obtaining auriferous pyritous ores on a large scale."

"The presence of so many intrusive dyke-rocks should lend encouragement to prospectors to continue prospecting operations, particularly in the neighbourhood of such intrusive rocks, because so far as has been proved in the vicinity of Cargo the most permanent of workable lodes occur as contact lodes between these intrusive dykes and the rocks which they have intruded."

Description of Mines.

The Ironclad Mine.

G.L. 133, parish Cargo, about a quarter of a mile west of Cargo, at the head of two shallow leads named Long and Tin Dish Gullies.

The workings of this once-important mine were not accessible during the present geological survey owing to the removal of the ladders to a depth of 300 feet, and in the absence of personal measurements and observations a series of notes on the general geology are here presented, together with reports by officials of the Mines Department, the whole being placed in chronological order, so as to simplify the method of presentation.

For the official notes on this mine prior to 1875, the reader is referred to the chapter on the history of the field by Mr. Warden Hutton, in "Mines and Mineral Statistics" for 1875.

The notes, up till the year 1890, are in the form of abstracts prepared from the official reports by Mr. J. E. Carne, Assistant Government Geologist, while the notes from 1890 onward have been selected from references contained in "A Register of Mining Localities in New South Wales" by Mr. O. Trickett. This applies also to the descriptions of other mining properties included in this report.

In 1875 the main shaft was 270 feet deep, the greatest depth reached in the district. The reef was better defined at that level than at points nearer the surface. A second vein was discovered 60 yards to the north of the workings. The battery was worked for seventy-five days only during the previous half-year owing to scarcity of labour, 1,200 tons being crushed for a yield of 600 ounces gold from the plates.

The tailings were treated in Munday's buddles, and the concentrates in three Wheeler's pans, roasting and retreatment in pans being the next stage in the gold-saving process. The total yield for the mine on the half-year was 863 oz. gold, of which 180 oz. were produced from 90 tons of pyrites, and 83 oz. gold from the treatment of 42½ tons by roasting and passing again through pans.

The plant of 1875 was found to be unable to compete with the accumulated pyrites. During the same period the Ironclad Company proved the reef to be well defined and with good quality stone to the boundary of the lease taken up by Mathieson and party. The latter had sunk a shaft down to a depth of 150 feet on a vein rather narrow but showing rich gold.

In the following year the mine was in full work, and employing from thirty to forty men. The main shaft was 338 feet in depth on a vein of very little width but of decided richness. On the southern end of the vein Mathieson and party were winning good stone, but were unable to treat it properly owing to lack of suitable machinery. So highly mineralised was the stone that half the gold was lost by ordinary treatment, and 150 tons of ore were accumulated during the year.

During 1877 the mine was steadily worked during ten months of the year. The shaft was down to a depth of 300 feet, and a contract had been let for the deepening of the No. 2 shaft from 100 to 150 feet. During this year the estimated output was 2,071 oz. gold from the treatment of 1,820 tons of stone.

In 1877, Mr. W. H. J. Slee, late Chief Inspector of Mines, reported that the machinery at the Ironclad included a 25-h.p. engine, a 15-head stamper battery, three Wheeler pans, and a Munday buddle.

For some reason the Ironclad Company adopted a secretive policy until 1884. Very little information was thus supplied for official publication. Almost the whole of the information which could be gathered from the official publications during the period 1877-1884 is that 1,200 oz. of gold were obtained during 1879, and that eighteen men were employed on the mine. Unofficial statements record the winning of £80,000 of gold by the company prior to 1885.

Very little work was done on the property under consideration in the period 1883-1885.

During 1885 490 tons of ore were treated for a return of 154 oz. gold.

In that year the Ironclad was once more in full work, having been purchased by an English company, who commenced operations in June. A trial crushing carried out in Sydney with stone secured from a depth of 80 feet in the shaft yielded a return of 2¼ ounces of free gold per ton, while the concentrates were reported to yield a return of 6 oz. 19 dwt. 9 gr. per ton. The old plant was found to be unable to cope with the peculiar conditions presented by the ore. A new plant was in course of erection during the year, and over forty men were employed about the mine. The greatest depth reached was 400 feet from the surface.

Reports in 1888 mention the flotation of the mine in England for £150,000, a large outlay being incurred in the erection of machinery for treating the refractory ore of the mine. During this year the company held 12 acres as leasehold and 10 acres as freehold.

In the following year the mine lay idle owing to want of water. New machinery was erected for the treatment of the refractory ore, and additional capital was obtained for the development of the mine. A new main shaft was commenced, having been sunk 163 feet to the end of the year.

In 1890 the Ironclad, embracing an area of 24 acres, employed twenty-eight men. The main shaft was sunk from 163 to 320 feet below the surface, and crosscuts put out thence at 200 feet for 30 feet, and at 300 feet for 20 feet. The lode opened up by this development was from 3 to 4 feet in width, being made up, according to report, of small veins of quartz and pyrites, the latter mineral yielding from 2 to 3 oz. gold per ton upon treatment. In practice some of the pyrites appears to have been picked out, while the remainder of the stone was put through the battery in the ordinary way, yielding from 1 to 3 dwt. of gold and 10 per cent. of pyrites as concentrates averaging 3 oz. gold per ton. 500 to 600 tons of ore were treated during the year.

New winding engines and Krom rolls were added to the plant.

Another official statement records the proving of the lode by a crosscut put out to a distance of 30 feet from the shaft at the 200-feet level. The vein here, however, was small, and of low grade. Only low-grade ore also was found in No. 2 shaft. During this year the treatment plant included ten head of stampers and thirteen Frue Vanners.

The enclosed report on this mine [see page 25] in the year 1890 by Mr. Geological Surveyor Anderson contains an excellent *resume* of the main features of geological and mining interest at the Ironclad. In this short note (Ann. Rept. 1890, p. 267), Mr. Anderson explains the difficulties under which the mining community suffered, namely, the irregularity in the size of reefs and the pyritic nature of the ore.

In 1891 mining was at a very low ebb at Cargo. The Ironclad Mine, upon which more than £150,000 had been spent since 1887, had ceased work, and there appeared no immediate prospect of securing fresh capital.

No mention is made of the mine in 1892, and in 1893, 1894, and 1895 it was shut down. During 1896 work was recommenced, and a water-jacket furnace was being constructed.

From 1896 until 1899, the Ironclad lay idle. The name Ironclad had, meanwhile, been altered to the New Cargo Gold Mining Company. In 1900, all the machinery on the Ironclad Mine, with the exception of a 20-head battery, had been removed and sold to a company at Mount Hope.

Since that date nothing of importance has been carried out at the Ironclad.

In any future attempt to work the Ironclad Mine the difficulty of effecting an economic gold recovery from the pyritic ore must be faced. The presence of copper, as recorded by Mr. W. Anderson and others, constitutes one of these difficulties.

In this connection, namely, the need for an effective but economic method of recovery of the gold from the pyrites, the following outline of a scheme for intending companies may be of interest:—

The stone could be crushed in a battery, the pulp passing thence through classifiers and thickeners to tube mills. The discharge from such tube mills might be passed over amalgamation plates and then conveyed to Dorr

thickeners by a large tailings wheel, or, preferably, by gravity, owing to the steep fall of the hillside. In these thickeners the moisture percentage is much reduced, and the surplus moisture passes off almost free from turbidity. From the thickeners the slime might then be passed to de-watering tanks, and there de-watered by means of Moore Vacuum Filter Baskets, the cakes so formed being passed into a vortex mixer and thus introduced to the action of cyanide solution, the resultant mixture being elevated to air agitators, the latter being worked on the continuous principle. From the agitators, through which the pulp passes in succession, it could be run off into filtering tanks. Here the gold solution could be acted upon by additional Moore Vacuum Filters, and the resultant cakes having been washed in fresh tanks could be passed into another mixer and thence conveyed to the waste dump or elsewhere.

The Dalcoath.

G.Ls. 60, 29 and M.T. 3, one and a quarter miles south-west of Cargo. This name has been applied to a group of mining workings situated along a line of lode on the southern end of Adelaide Hill. It has been reported upon under various names, the latter also under various spellings. Thus the titles, Dalcoath, Dolcoath, Dolcoath Hill, Dolcouth, Dalcooth, The Dalworth, The Dulwood, Durwood Hill, and the Mt. Durwood, appear to refer to the same line of lode.

This lode appears to have been one of the most important on the Ironclad Range, and from both it and the associated reefs has been shed the gold which has enriched the drifts of Gum Flat.

It appears to have been worked in the early days of the field, but very little reference has been made to it in the official literature dealing with Cargo.

In "Mines and Mineral Statistics" for 1875 Mr. Mining Registrar Hutton mentions the Dolcoath as one of the four important reefs of the field, but he supplies no details of yields.

In 1879 Clerk and Thomas were working on a supposed continuation of the Dalcoath. The vein was narrow but rich, and 30 tons were treated for a return of 1 oz. 7 dwt. gold per ton.

During the following year 28 tons of ore yielded 45 oz. 18 dwt. gold.

The next record is in 1883, when Thomas and party sold a parcel of 20 tons for a return of 15 oz. gold.

In 1887 Sharp and party produced 23 tons for a yield of 39½ oz. gold; 1 ton of picked stone yielded 25 oz.; while 4 tons sent to Sydney yielded 4 oz. per ton. The pyrites were sent to England.

In 1890 two shafts were sunk on this line to depths of 90 and 140 feet respectively. 100 tons of ore were raised, but no battery was owned by the working parties. The value of this 100 tons is not known.

In the following year 6 tons of stone from this line were treated at the Clyde works for a return of 2 oz. 7 dwt. free gold per ton, and 2 oz. from the pyritic tailings. The pyritic contents of the ore were considerable. The reef itself was recorded by the Mining Registrar as being from 2 to 4 feet in width. Shafts had been put down to depths of 96 and 176 feet from the surface, and a drive put in for a distance of 50 feet to the east at a depth of 170 feet. In the shallower shaft the reef had been stoped for a length of 30 feet on each side of the shaft up to within 20 feet of the surface. 150 to 200 tons of ore had been accumulated pending the erection of machinery.

During the year 1890 Mr. W. Anderson, Geological Surveyor, reported on the mine as follows:—

> "About 2 miles to the south of the Ironclad is a mine known as the Dalcooth. The outcrop of this lode runs nearly north and south, and a great deal of work has been done in the sinking of shallow shafts upon it. The deepest shaft sunk by the present party is down 130 feet on the underlay of the reef. From what I could learn the reef was of a similar character to the Ironclad and passes at a depth into an iron and copper-pyritous lode. In thickness it varies from a few inches to over a foot, and has, according to report, yielded good returns. As there was no one at work at the time of my visit I was unable to examine the underground workings, but from what I could gather from the rocks, which had been brought to the surface from the various shafts, the lode seems to occur among a similar set of rocks to those among which the Ironclad lode occurs. From some specimens which were picked up here it would appear as if the dyke rock was more of the nature of a dioritic or syenitic rock, consisting chiefly of altered hornblende and felspar. There is a great likelihood that this lode occurs along the junction line of the same dyke upon which the Ironclad lode occurs, although in the two positions the dyke rock presents a considerable difference in structure and composition. In both places, however, it has originally contained a large percentage of hornblende which has now been much decomposed and in places altogether replaced by chlorite. The decomposition of the hornblende in the dyke rock has no doubt largely increased the quantity of free gold in the lodes, particularly in the upper superficial parts, for it is a well-known fact that the ultimate analysis of hornblende almost always produces traces of gold. From its position it is probable that it will be found like the Ironclad to be persistent to a considerable depth."

In this brief report Mr. Anderson suggests that the dyke, to whose presence the Ironclad owes its existence, has also determined the Dalcoath line of lode. There is much to favour this idea. In the first place the trend of the dyke at the Ironclad is almost the same as that of a line drawn direct between the two lodes, and moreover, in the present survey, a dyke, similar in appearance and strike to that of the Ironclad, was observed to have intruded the felsites on the roadside in G.L. 95 and lying in the direct line connecting the lodes under consideration. The country surrounding the Dalcoath consists of dense, and finely-textured tuffs and lavas. Rocks of andesitic and doleritic types lay around the shafts, but their relation both to the lode and to the prevailing rock masses of the vicinity were not ascertained inasmuch as the mine workings were not accessible, nor was it possible to find a good natural section of the country near the lode. Mr. Anderson's statement that the Ironclad and Dalcoath lodes are probably both of similar character appears to be correct.

The Mining Registrar in 1891 reported that: "At the Dalworth Mine two shafts have been sunk 150 feet deep and 22 feet, with 268 feet of driving. 123 tons of stone have been raised during the past year, and crushed for a return of 1 oz. 7 dwt. per ton." This refers evidently to the Dalcoath lode.

Very little work appears to have been carried out during the period 1892-1898. In 1898 £12,000 worth of machinery had been erected, but owing to lack of water supply no crushing was carried out.

In the following year the Mount Durward (Dalcoath) was practically abandoned owing to the non-payable nature of the ore treated, although £12,000 to £14,000 had been expended in machinery.

In 1901 Henry Moore forwarded a parcel of 12 tons of ore from the Dalcoath, from which 47 oz. gold were won.

In 1903 W. M. Collins crushed 4½ tons of stone yielding over 1 oz. gold to the ton.

During the same period Thompson and Moore sank their shaft to a depth of 135 feet. A crushing of 25 tons of stone yielded 116 oz. gold, valued at £464.

In 1904 Moore and Thompson crushed 41 tons from their lease for a yield of 246 oz., valued at £984. Driving has been done east and west at the 100-feet level.

Several other small crushings have been reported, and these have been sufficiently encouraging to stimulate further prospecting.

The mine had been known for several years previous to this as the Mount Durwood.

In 1906 Moore and others crushed 18 tons for a yield of 88 oz., valued at £360, and L. Tinnock crushed 12 tons for 60 oz. gold. The name of the lode from which these returns were procured is not supplied, but it is probably the Mount Durwood.

In his report for the year the Mining Registrar states:—"The veins are, however, very narrow, and, as a rule, no quantity of ore can be obtained." (Ann. Rept. 1906, p. 12). In this sentence the Mining Registrar appears to sum up the results of the work done on the smaller reefs of the field.

In 1908 G. Tinnock crushed a parcel of 5 tons of stone for a yield of 18 oz. gold.

Very little work has been done on the lode since that period.

The Golden Clad.

G.L. 80 and other leases, parish Cargo, about half a mile west of Cargo. The Golden Clad lies in the saddle connecting the New Chum and Ironclad Hills. The country consists of igneous rocks, probably dolerites, associated with trachytes, near their junction with felsite. Numerous shafts have been sunk along the line of lode, and rich stone of pyritic nature appears to have been obtained therefrom, but its occurrence is patchy and its nature refractory. It is therefore difficult to treat the ore from this lode with ordinary crushing machinery.

The Golden Clad is the old Rise and Shine, the name having been changed about twenty-five years ago.

The lode is mentioned in "Mines and Mineral Statistics" for 1875.

In 1879, according to the report of the Mining Registrar, the value of the stone raised varied from 15 dwt. to 3 oz. gold per ton, while in the following year 8 tons were raised for a yield of 12 oz. 11 dwt. gold.

In 1889 the Mining Registrar reported that the mine under consideration (Rise and Shine) had been owned previously by W. J. Franks, but had passed, at the period stated above, under the control of a company with a capital of £30,000. A large dam had been formed, and the erection of a crushing plant was contemplated.

The Mining Registrar reported in 1890:—"On the Golden Clad, a mine about 1 mile due west from Cargo, 28 acres are held under lease by the Golden Clad Company. This mine has been working for about two years, and a great deal of money has been expended on it. About 1,400 to 1,500

tons of stone are at grass, and will shortly be crushed. Some stone from this mine, treated at the Clyde works, gave 1 oz. 6 dwt. and 18 dwt. per ton—an average of 1 oz. per ton. The main reef is very large, being 9 feet wide. Other reefs in the same ground are 2 and 3 feet wide respectively. The company are not working at present, having ordered machinery from England suitable for treating what must be considered refractory ores." [Ann. Rept. 1890].

During the same year Mr. Anderson, Geological Surveyor, reported on the mine as follows:—

> "On the hills to the north-west of the Ironclad numerous parties have at one time and another sunk numbers of shafts on small leaders, which, however, have not proved of sufficient width nor thickness to encourage them to proceed to any depth with them. One of these claims is known as the Golden Clad, which consists of thin veins of gossan (decomposed pyrites), which have been sunk upon to a depth of 60 feet. Crushings from this claim are reported to have gone about 1 ounce to the ton, but the veins are so thin that the expense of getting out the ore in sufficient bulk would be too great to work the vein by itself. The same party have, however, another claim on the south-east of the Cargo and Canowindra-road in which there is a considerable bulk of surface stone which, on assay, yields a few dwt. per ton, and which the party purpose to treat with the Golden Clad stone. In the claim referred to, on the south-east of the road, there are no evidences of reefs or lodes, but the quartz-porphyry has local areas in it which almost entirely consist of ferruginous gossan carrying a little gold. These areas have, no doubt, been originally occupied by iron pyrites which, by segregation, have formed specialised areas, the pyrites in which has subsequently undergone decomposition, leaving a siliceous gossan, containing a small percentage of free gold. One such patch of gossan has already been opened out, and appears to be of considerable extent, but when they are sunk upon, if they extend below the water level, the gold will be wholly confined to the undecomposed pyrites. The occurrence of these segregated patches of pyrites will be found to be very uncertain and their individual extent will be exceedingly irregular."

During the following year a battery was erected at a cost of about £2,500, but no stone was raised.

Nothing further has been reported concerning this mine since 1891.

The Cargo Consols.

G.L. 124, parish Cargo, about 25 chains south of Cargo, on the northern aspect of the Adelaide Hill. The lode has a strike almost north-east and south-west. The dip is almost vertical. Underground workings have proved the existence of the lode for a distance of about 125 feet. The outcrop is an altered ironstained felsite, cellular, and slightly cavernous in places. The ore values themselves appear to be intimately associated with a wide zone of alteration supposed to be a "felsite dyke" by the mining community. This idea of intrusion by an igneous rock has been suggested by the silicification and pyritisation to which the country felsite has been subjected in a marked manner. The "vein" itself is of irregular width, being reduced in places to a mere narrow joint, and in others spreading out to a width of 10 feet. The ore channel is frequently marked by the presence of a coarse breccia, the fragments of which are of altered felsite frequently studded with crystals of iron pyrites, and sometimes cellular by reason of the leaching action to which the cubes of pyrites have been subjected. The

material forming a cement to the breccia is of variable nature, in places appearing to be a tough clay, and in others a more friable material, reddish under certain conditions.

During the examination of this mine the floor was covered with debris and water, and the walls had not been cleaned, nevertheless, in our opinion, there is no direct evidence of the faulting of the main ore channel to the west, and it is probable that the vein has been pinched locally at the deepest point yet reached, and may open out at points lower down. In view of the facts, however, that the lenticular bodies of pay-ore have been removed from the portions of the lode already opened up, and that little or no trace of the ore channel is to be seen in the faces and the floor, partly because of the pinching of the ore bodies at these places and partly for the reasons already set out, we have found it impossible to hazard any opinion other than that a considerable amount of ore has been won from lenses of stone, and that other lenses doubtless exist in the vicinity.

The accompanying plan and section copied from the originals in Mr. McMahon's possession illustrate the irregular nature of the ore distribution.

The following notes have been extracted from the annual reports of the Department of Mines, and from notes supplied by Mr. McMahon:—

In the report for 1875 it is stated that Campbell and party worked on the Adelaide reef during the last three months of the year. They sank 40 feet on a vein 6 feet wide, and have about 70 tons of ore at grass. The next mention of the reef is in the 1906 report, when the name of the reef was changed. It is stated that McMahon and party re-opened the Cargo Consols Mine at Adelaide Hill, and treated 77 tons of ore from the 50-feet level for a yield of 67 oz., valued at £250, exclusive of concentrates. The ore body is said to vary in width from 3 feet to 10 feet, and the gold contents to range from 3 dwt. to 20 oz. per ton; the richest portion occurring on the foot-wall.

In 1907 J. McMahon and party treated 110 tons for a yield of 78 oz., valued at £272, and, in addition, 43 tons of residues were treated for 35 oz. bullion, valued at £80.

J. McMahon and party, during the year 1908, received aid from the Prospecting Vote to test what appeared to be a well defined lode formation on Adelaide Hill. Some 280 tons of material were treated for a yield valued at £314.

Mr. John McMahon, who at present holds the lease over the Consols Mine, states that "the lode has well-defined walls, and can be traced on the surface for a distance of over 200 feet in a north-easterly and south-westerly direction. The ore body varies from 2 feet to 10 feet in width, and is composed of soft friable material heavily charged with soft red and yellow oxide of iron. Patches of dense ironstone, some containing as much as 7 oz. 13 dwt. of gold per ton, occur in the lode."

"There was a bank in the ore channel of about 12 feet, between the perpendicular of the ore bodies at the 34-feet and 50-feet levels, as shown on the sectional plan of the mine."

"175 tons of ore raised from between the 50-feet and 70-feet levels gave a gross return of £717 12s., or nearly £4 2s. per ton. To this must be added 4 dwt. per ton on 80 tons of residues from the vats, equal to £64. The slimes and tailings assayed from 15 dwt. to 20 dwt. per ton. A patch of ironstone outcrops near the south-east corner of the lease. Ten tons of loose boulders taken across the outcrop yielded 19½ dwt. of gold by battery amalgamation."

The Commonwealth Gold Mine.

The mine is situated about 1¼ miles north-westerly from Cargo, on portion G.L. 92, parish Cargo, county Ashburnham.

The reef occurs in andesitic rocks, and may possibly be an extension of Mobbs' Reef, or Gazzard's Reef, which occur to the north and south respectively. It has a general north-westerly and south-easterly trend, and dips to the north-east.

The ladders having been removed from the shaft, it was not possible to examine the workings.

Mr. John McMahon, one of the original prospectors, states that the shaft, which is sunk on the reef, is vertical for the first 40 feet, and then underlays to the bottom—106 feet. The hanging-wall country is porphyry, and the foot-wall andesite.

The vein has been driven on for 40 feet in a north-westerly direction, and for 16 feet south-easterly. It averages about 12 inches in width, and is composed mainly of quartz, ironstone, kaolin, and crushed gossan material, with bunches of calcite and sulphide of iron in places. The average yield is about 12 dwt. per ton.

Some 30 feet north from the shaft a winze has been put down, which has exposed six veins aggregating over 4 feet in width. An average sample from the veins yielded 2 oz. to the ton. The ore from the winze treated at the battery yielded 9 dwt. to the ton, and the concentrates 14·80 dwt.

The following notes on the mine have been extracted from the departmental records:—

> The first mention of this mine in the departmental publications is in the annual report for the year 1899, wherein it is stated that "McMahon brothers have been prospecting for nearly two years on the Commonwealth Gold Mining Coy., Cargo, in the endeavour to develop a true fissure lode in connection with the main dyke on the field. The principal shaft is down 106 feet on the underlay, where a level has been driven 13 feet southerly and 45 feet northerly on a vein of ore averaging 18 inches in width. Sixty-nine tons of ore obtained in sinking and driving have been treated at a local battery for a yield of over 12 dwt. per ton, but owing to the loss of fine gold in the slimes it cannot be worked profitably with the available method of treatment. Ore from the north end of the level, where a new chute was cut, giving an average assay of 2 oz. 1 dwt. to the ton, yielded only 9 dwt. to the ton by battery treatment. The ore in the face is 3 feet wide. A winze is now being put down 30 feet north of the shaft, and at 8 feet below the 106-feet level six samples were taken across the lode and assayed with excellent results. The winze is just entering the mineral zone, but so far is free from any trace of copper or arsenic, the gold being in common iron pyrites. The width of the lode is not known. In the ore occasional deposits of white decomposed felspathic mineral are met with, which invariably carry the best gold."
>
> In the 1900 report it states that "a lot of prospecting was done, and very good samples of ore taken out, but the owners, Messrs. McMahon Brothers, were under a great disadvantage in working the property, owing to the nature of the ore, which is mostly pyritic, while there is no machinery at Cargo capable of treating the stone successfully."

During the years 1899 and 1900 some twenty samples submitted by Mr. J. McMahon and stated to come from the Commonwealth Mine, Cargo, were assayed in the Departmental Laboratory, the results varying from traces of

gold and silver per ton up to 4½ oz. gold and 1 oz. silver per ton. The stone is described as ironstone gossan, pyritous ironstone, pyritous chloritic schist, pyritous chloritic schist with a little copper pyrites, siliceous ironstone, &c. &c.

The Essex.

G.L. 65 and others, parish Cargo, about three-quarters of a mile south-west of Cargo. The country is of dark-coloured igneous rocks near their junction with felsite. From an examination of the spoil heaps lying near the shafts it is probable that a dyke rock of intermediate or basic composition is associated with the lode. The strike varies from N. 80° W. and S. 80° E. to E. and W., and the dip is towards the south and almost vertical.

The first work was done by A. Tinnock and party. The main shaft is reported to have been sunk to a depth of 150 feet under aid from the Prospecting Vote. The veins are described as small and of irregular nature by Messrs. McMahon and Hennesy. Iron pyrites occurs in the lode proper, and is also developed in the altered igneous rock alongside in the form of small flakes and plates and crystal aggregates, arranged sub-parallel to the trend of the veins themselves.

A list of smelting returns purporting to have been obtained from this lode has been supplied by Mr. J. McMahon. These indicate a treatment of 85 tons 4 cwt. for a return of £1,892 8s. 2d. after payment of all expenses.

No mention is made of this mine in the official publications. It is probable that the mine was known under a different name in the early days of the field, and that some of the returns of ore from the Cargo mines appearing in notes which follow have reference to this reef.

Other Lodes.

A number of reefs, apart from those described individually, have been worked, but are apparently only of minor importance. Most of them have apparently been worked only to a shallow depth, and little information could be obtained locally concerning them.

The following notes extracted from the departmental reports refer to a number of such occurrences.

Annual Report, 1875.—Elder and party are working on their lease on Victoria Reef; they have not had any crushings during the past six months, as they have been engaged sinking a new shaft; there are a great number of small veins in this ground.

Mathieson and party have sunk to 150 feet; they have a vein in the shaft which shows good gold, but is rather narrow. They do not intend to open out until they reach the depth of 200 feet.

Annual Report, 1876.—Elder and party had a crushing of 12 tons lately, which yielded 2 oz. of gold to the ton. There is a net-work of rich but very narrow veins on this property.

Mathieson and party have 150 tons of ore at grass. It contains so much pyrites and other mineral that ordinary treatment would not save one half of the gold.

Annual Report, 1877.—Elder and party, on the Victoria Reef, had a crushing of 12 tons, which yielded 14 oz. of gold.

Annual Report, 1878.—Mathieson and party, Ironclad Reef, have done a great deal of work. They have several small veins, which carry good gold.

Elder and party, Victoria Reef, have lately had a crushing of 23 tons, which yielded 29 oz. gold. There was a large quantity of pyrites in the ore treated.

Annual Report, 1879.—Elder and party had a crushing of 13 tons, which yielded 2 oz. to the ton. The reef is situated on a spur of the Ironclad Range. The returns from a number of small crushings aggregating 150 tons gave a gross yield of 333 oz. 2 dwt. 7 gr.; one lot of 1 cwt. 3 qr. 12 lb. of stone yielded 19 oz. 7 dwt. A sample of the tailings was tested at the Mint, and gave 1½ oz. to the ton.

A claim on what seems to be a continuation of the Dalcooth Reef is being worked by Clerk and Thomas; this vein is very narrow. A trial crushing of 30 tons yielded 1 oz. 7 dwt. to the ton.

The following is a list of reefs, with the results of trial crushings, which were obtained from them several years ago:—

McGinnis Reef—McGinnis and party—Yielded 1 oz. 10 dwt. per ton.

Homeward Bound Reef—Duff and party—Several crushings yielded from 15 dwt. to 1 oz. 9 dwt. per ton.

Homeward Bound Reef—Alderton and Coy.—50 tons yielded 100 oz.

Mobbs' Reef—Mobbs and Coy.—1 oz. to the ton.

Alpine Reef—H. C. Wall and party—Crushed at Grenfell, 2 oz. to the ton.

New Chum Hill—Oswell and party—9 dwt. per ton.

Rise and Shine—Prospectors—Several crushings from 15 dwt. to 2 oz. 10 dwt. per ton.

Rise and Shine—Coomber and Coy.—Several crushings from 15 dwt. to 3 oz. per ton.

Last Push—Hawkins and Co.—15 dwt. per ton.

Prince Alfred Reef—Clerk and Co.—5 dwt. per ton.

Lucknow Reef—Perry and Co.—2 oz. per ton; three dishes gave 9 oz.

No. 2 South Ironclad Reef—3 tons yielded 100 oz. gold.

No. 4 South Ironclad Reef—Scofield and Co.—15 dwt. per ton.

Adelaide Reef—Campbell and Co.—15 dwt. per ton.

Galatea Reef—Craven and Co.—Several crushings 15 dwt. to 1 oz. per ton.

Annual Report, 1880.—Several reefs have been partially worked during the year. The following is the result of their crushings:—

Rise and Shine Reef—Roberts and Thomas—8 tons yielded 12 oz. 11 dwt.

Homeward Bound Reef—Nelson and Duff—17½ tons yielded 33 oz. 12 dwt.

Dalcooth Reef—Thomas and Clerk—20 tons yielded 27 oz.

Dalcooth Reef—Elder and Co.—8 tons yielded 18 oz. 18 dwt.

Phœnix Reef—Elder's lease—6 tons yielded 12 oz. 10 dwt.

Annual Report, 1881.—Duff and party had 14 tons treated from their claim on the Homeward Bound Reef for a yield of 35 oz. 5 dwt. of gold.

Mathieson and party have been working their lease on the Ironclad Reef but have had no crushings.

Annual Report, 1882.—Simmons and party raised 45 tons of quartz from the Homeward Bound Reef.

Annual Report, 1883.—Simmons and party had 40 tons from the Homeward Bound Reef crushed for a yield of 1 oz. to the ton. The ground has since been abandoned.

Thomas and party crushed 20 tons from the Dalcooth Hill for a yield of 15 dwt. per ton. The patch in this ground is worked out.

Annual Report, 1887.—Sharp and party, on Dalcooth Hill, had a crushing of 23 tons for 30 oz. 10 dwt. 12 gr. They also crushed 1 ton of picked stone for 25 oz. of gold; 4 tons of stone sent to Sydney for treatment yielded 4 oz. per ton of free gold. The pyrites have been sent to England for treatment. Mobbs and party are also working on this line of reef.

Annual Report, 1888.—Steele and party, on Dalcooth Hill, are cross-cutting for their vein at a depth of 180 feet.

Annual Report, 1891.—At New Chum a rich vein has been struck in Mr. A. Tinnock's 1-acre lease.

Annual Report, 1893.—A. Tinnock struck a rich patch about 2 feet from the surface, which yielded 80 oz. of gold, but after sinking a few feet the shoot cut clean out.

Annual Report, 1899.—The Capital Gold-mining Syndicate (no liability) is working the property adjoining the New Cargo Gold-fields on the north-east, and prospecting has been continuously carried out on it for the last twelve months. There are five shafts on the ground, of the following depths.—45, 60, 50, 57, and 100 feet, from which various drives have been put in, aggregating about 200 feet. From the 57-feet shaft, within 6 feet of the boundary of the New Cargo Gold-mining Company's ground, two parcels of ore have been treated at the local battery. The first (10 tons) yielded 11 dwt. per ton by amalgamation. The second lot of 60 tons, taken from a lode 9 feet wide, yielded at the rate of 4 dwt. 2 gr. to the ton. In the 45-feet shaft, which is about 300 feet west of the boundary shaft, a vein of ore 12 inches wide is showing in the bottom, and is estimated at a value of ½ oz. of gold per ton. This shaft is within 15 feet of the boundary of the New Cargo Gold-mining Company's property. At present work is confined to the 100-feet shaft, on the eastern slope of the hill, from which a drive is being extended in the direction of the 45-feet shaft, the purpose being to intersect the western branch of the Ironclad lode, and prove the value of any intermediate veins which may be met with, surface prospects indicating payable gold deeper down.

Annual Report, 1901.—Tinnock and Mobbs, from their 3-acre lease, near Copper Gully, obtained 80 oz. of gold, valued at some £300, from 20 tons of stone.

Annual Report, 1903.—A. Tinnock, on an area of abandoned ground, sank a shaft to a depth of 40 feet, on a vein 15 inches wide, a parcel of 8 tons from which returned 54 oz. of gold.

Mobbs and Tinnock, at Mount Durwood, crushed 30 tons for 80 oz. of gold.

Annual Report, 1906.—G. Tinnock treated 12 tons for 60 oz., valued at £240.

G. Cridland had 9 tons treated for 20 oz., valued at £70.

G. Hibberd treated 12 tons for 16 oz., valued at £64. The veins are very narrow.

Annual Report, 1907.—G. Tinnock and H. Moore and party, Dalcoath Hill, treated 8 tons each for a yield of 32 oz. and 30 oz. respectively.

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GEOLOGICAL MAP
OF THE
CARGO GOLD FIELD

Geologically surveyed by E. C. Andrews, B.A., Geological Surveyor, and M. Morrison, Assistant Geological Surveyor.
Prepared under the direction of E. F. Pittman, A.R.S.M., Government Geologist and Under Secretary for Mines,
Department of Mines, Sydney, 1914.

Scale 0 10 20 30 40 Chains

0 1 2 3 4 5 cm

REFERENCE

- Alluvial
- Silurian (?) Contemporaneous lavas, tuffs, breccias, claystones, limestone, &c.
- Aplitic Granite
- Felsite, in which most of the gold occurs

PARISH OF CARGO

COUNTY OF ASHBURNHAM

TOWN OF CARGO

Racecourse

Old Workings

Shaft 110ft deep in Alluvium

Scrape Rock Gully

McBB's Shafts

Commonwealth Shaft

Cary's Paddock Shaft

Gazzard's Shaft

Andesites tuffs, breccias, &c.

Ironstone

Jasperoid rocks, Tuffs, &c. Syenite porphyry

Trachyte Pyritic zone

Tin Dish Gully

Greenish Andesitic rocks

Basic to intermediate breccias

Golden Clad Shafts

O'Neill's Shaft

Patches of fine grained tuffs and andesites

Shafts 80' Rounded wash

Fine grained andesites

Essex Shafts

Much prospecting hereabouts

Tuffs, &c. Dip variable

Felsites, and tuffs

Lavas and tuffs

Graveyard Gully

Township Gully

Road

New Zealanders Shaft 380'

Harrie Wood's Shaft

Deep Shaft 350'

Wash which has been prospected in a number of shafts

Gum Flat Line of Lead

Alluvial workings

Cargo Creek

Rifle Range

Porphyritic andesite

Small patch of ironstone

Shallow Trachytic rocks

Pyritic zone

Andesites

Aplitic Granite

Porphyritic Andesites,

Old Workings

Alpine Reefs

Homeward Bound Line

Old Logging alluvial workings

Shallow workings

Andesites

Pyritic zone

Trachyte

Pyritic zone

Dolerite dyke hereabouts

Surface workings

Secretary Shafts

Sorcerer's Shaft

Graveyard Gully

Township Gully

Andesites

Porphyritic

Andesites

Gerybong Creek

Dalcoath Line Deep Shafts

Shafts

Alluvial workings

Shallow workings

Shafts 240'

Shaft 350'

Shafts 80'

Rounded wash

Andesites

Andesites

Andesites