

recorded from Texas, U.S.A. The chief constituents of the three Wodgina minerals are:—

| | Mackintoshite? | Thoro-gummite? | Pilbar-ite. |
|--|----------------|----------------|-------------|
| Thoria, ThO_2 | 24.72% | 24.46% | 31.34% |
| Uranium dioxide, UO_2 | 35.60% | none | none |
| Uranium trioxide, UO_3 | trace | 37.33% | 27.69% |
| Radium by calculation, centigrams per ton | 11 | 10 | 7 |

All three minerals are of high commercial value, and representative samples have been requisitioned from England, France, and Germany for experimentation on industrial lines. A detailed description of their occurrence, composition, and properties is now in course of preparation.

RUTILE (oxide of titanium) has been known for some years to occur at Yulgering Spring in the Avon district. Recently a typical sample has been shown to contain:—

| | |
|--|--------------------|
| Titanium dioxide, TiO_2 | 94.97% |
| Iron sesquioxide, Fe_2O_3 | 2.81 |
| Chromium sesquioxide, Cr_2O_3 | .33 |
| Silica, etc. | 2.36 |
| | <hr/> 100.47 <hr/> |

Its comparative purity having thus been established, efforts are now being made to open up the deposit and export the mineral. Its chief application is in the manufacture of titanium-steel rails.

AMBLYGONITE, a commercially valuable fluo-phosphate of lithium and aluminium, has been detected in specimens from a pegmatite vein at Ravensthorpe. It has previously been recorded from Ubini.

BARYTES (sulphate of barium) was discovered at Cardup Brook near Beenup, but samples submitted were not sufficiently pure to be of commercial value. A bulk sample yielded:—

| | |
|--|---------|
| Barium Sulphate, Ba SO_4 | 55.33 % |
| Silica, Si O_2 | 36.98 % |

Three new metallic METEORITES have been examined during the year, two being from Premier Downs in the Eucla Division, the third from Mt. Dooling in the Ullaring district. Descriptions of two of these have been prepared for inclusion in a Bulletin.

PETROLOGICAL WORK.

Mr. Farquharson, who had been specially appointed at Petrologist to assist in undertaking the whole of such work required in connection with the field operations carried out by the Department, reports upon his year's work in the following terms:—

My first care, after entering upon the duties of my office on the 20th April, 1911, was naturally to become as fully conversant as possible with the state of knowledge of the geology, and in particular of the petrology, of the colony in so far as it could be gathered from the specimens and publications of the Survey. Accordingly, with the exception of determining various specimens for the Mines Department, I spent the month of May in going over both the mineral and rock collections of the Survey in the Museum and the large collection of rock slides in the office. It was soon apparent that many of the identifications of rocks were not quite up to modern nomenclature. From May onwards, therefore, as opportunity has permitted, I have devoted considerable attention to naming the collections, with the object of ultimately forming an arrangement of the rocks of the State that will serve as a reference for the officers of the field staff and as a guide for the general public.

Apart from this work, from June to the end of December I have been busily engaged along a variety of lines. To begin with, there have been many determinations to be made of both minerals and rocks for prospectors and mining men, and even for settlers. One group of specimens identified is specially worthy of mention, viz., that sent down at intervals from a locality about 40 miles west of Mount Magnet and a mile or two north of Yoweragabbie. These included massive fibrous tourmaline—schorl rock—and corundum. When it is remembered that these minerals are very frequently associations of cassiterite, it will

be obvious that a careful prospecting of the locality for tinstone is highly desirable.

There has further been a considerable amount of material reported on in connection with bores put down for water. In particular, the cores of the Cookernup bore down to a depth of 2,215 feet have all been carefully examined and described, and it has been shown that, while the supply got has, up to the present, been limited, bedrock has not yet been reached. Various specimens from other bores have been reported on, and in several cases information and advice have been given direct to those who have come for it. During the former half of the month of June I was occupied chiefly in determinations of numerous specimens from Southern Cross for Mr. St. Smith's report. Some of the results have already appeared in the Preliminary Report on that field. The striking feature of these rocks was the very large number of hornblendic varieties. From a consideration of them, it is certain that many are altered forms of gabbros and dolerites in which the original augite has been changed by dynamic action to hornblende or uraltite, while the feldspars have been bent, broken, or faulted. It would, therefore, appear that many of these rocks are very old plutonic intrusions, and that, subsequent to their consolidation, they have been acted on by great earth movements, evidences of which exist all over the State. As the result of these movements, large anticlinal and synclinal faults and fault-planes, as well as fissures, have probably been produced, and these planes of weakness thus produced have allowed of the penetration of ore-bearing solutions, which have doubtless accompanied late acid and basic intrusions. Sufficient evidence is not yet available to enable a theory, properly worked out and based on the results of modern petrological work, to be put forward, but there can be little doubt that the outcome of the more or less regional survey of the Kalgoorlie field at present being undertaken, together with the deductions of the all-important petrological work, will go far towards clearing up the structure of the interior of the State and towards a true explanation of the genesis of the ore-deposits, and thus tend to materially assist the mining industry. Determinations of a number of Kimberley rocks also occupied part of my time in June. The detailed results of the examination of these will appear in the Kimberley Bulletin. Suffice it to say here that conspicuous among the specimens are various fresh and amygdaloidal dolerites, some ferruginous sandstones, and three specimens of highly epidotic rocks, one an epidosite, the other two probably epidotised diorites or related rocks. One of these two has a mineral which, pending a chemical analysis, is to be referred to glaucophane.

The latter half of June, in accordance with instructions, I spent in a brief examination of the rocks of some of the mines on the Eastern Goldfields.

During July attention was paid to some rocks from Warrawoona, two of which are described in detail for a forthcoming Bulletin. The interest of these rocks is that the existence of metamorphosed sediments in this district has been definitely established and the views previously held by the Government Geologist as to the origin of the formations at least partly confirmed.

An investigation was also begun into the origin of the so-called Banded Ironstones, which form such a peculiar feature of the landscape and geology of the State. So far as the results of this research, extending at long intervals from August to December, have shown, some at any rate would appear to be weathered and altered forms of heavily pyritised hornblendic rocks. Very similar formations, called Amphibole-Magnetite rock, have been described in particular, from the Cuyuna Iron Range, Minnesota, in association with cherty iron carbonates, ferruginous cherts, etc. On a recent visit I paid to the Nemesis Mine at Tuckanarra in the Murchison Goldfield, specimens were obtained which appeared to show the passage from the ferruginous schists on the surface to a rock almost identical with the amphibole-magnetite rock of the Cuyuna. The actual mineralogical determination of the amphibole has not yet been made out but it is probably, in part at least, the species grüncrite. According to F. S. Adams, "this amphibole-magnetite rock was produced by partial anamorphism of the original iron formation due to heat and pressure developed by con-

tact with intrusive, and by acute folding." It is important to note that in several instances these banded rocks are auriferous, especially where they are intersected or interrupted by quartz reefs. Unfortunately, owing to the large amount of work to be done for the field staff, a continuation of the investigation has had to be deferred.

In August, besides a considerable number of determinations for Mr. Blatchford and a report on other Southern Cross rocks, an examination was made of several specimens from the Whim Well Copper Mine, West Pilbara Goldfield. These were all highly altered rocks, now consisting some almost wholly of chlorite and secondary quartz, others of kaolinised feldspars and quartz.

Following on a determination in September of an obscure rock for Mr. Turner of the Ingliston Extended Mine, Meekatharra, a batch of the country rocks of the lode formations in this field was sent down, and since, hitherto, descriptions of these rocks had been couched in the vaguest terms, a thorough petrological examination of them has been made and an attempt to arrive at some conclusions as to the original rock and the original of the lode material. The results will be published in a forthcoming Bulletin. From the 13th to the 14th I visited Kelmseott to report on a supposed building stone in the vicinity. In spite of a diligent search, none of any quality was discovered. From the 19th to the 22nd, inclusive, I was at Collie with a view to the examination of the district.

From the beginning of October to the middle of November, my time was largely spent in reporting on rocks from Coolgardie and Burbanks for Mr. Blatchford, on specimens from the Yilgarn and Yalgoo Goldfields for the Government Geologist, on some Meekatharra specimens, and on rocks from Recovery G.M.L.L. The results will very shortly be published.

About the middle of November, seeing that for months previously it had been pretty evident that there was considerable confusion with regard to rock terminology and the principles on which it is based, I undertook to write a paper which should contain not only descriptions of the more important rock-forming minerals from the point of view of those characters which would enable an identification of them to be made with the naked eye or a lens and a pocket-knife, but also a rock classification with the names and a brief account of the chief rocks of general occurrence. This paper will be published in the forthcoming Bulletin containing the various miscellaneous Reports. During December the paper was finished, numerous determinations were made for Mr. Woodward's Report on the Peak Hill District, for Mr. Talbot's Report on his flying Survey of the North Coolgardie Country, and a report was made on a collection of specimens from the deep mines of Kalgoorlie for the Royal Commission on Miners' Lung Diseases. These latter rocks, though very much altered, can be roughly classified under two or three heads, and a close comparison of them with others in the collection will throw a considerable amount of light on the original rock facies of that field.

PALAEONTOLOGICAL WORK.

During a short visit to the Collie Coalfield in the month of September, Mr. Farquharson collected several fossil leaf impressions at West Collie, of which a more or less preliminary examination has been made. The results of this investigation have once more raised doubts as to the Permo-Carboniferous Age of the Coal Measures. No impressions demonstrably of "*Glossopteris browniana*" were obtained by Mr. Farquharson; on the other hand there were one or two extremely like those of certain Upper Mesozoic and Early Tertiary plants from New South Wales. It is contemplated making a fuller collection before any definite conclusions on the question are published.

LIBRARY.

As has been the case in the past, the Library has received a considerable number of additions during the year under review, having been increased by 741 presentations and 95 purchases.

GEOLOGICAL SURVEY COLLECTION.

The additions to the Survey Collection during the year 1911 amounted to 761, bringing the total number registered up to 12,097. The accessions comprised 174 minerals, 535 rocks, 39 fossils, and 13 bore-cores. Of microscope slides 228 were prepared during the year, and added to the collection under the care of the Petrologist, bringing the total number now on the books up to 1,675.

The officers of the Survey have, in the ordinary course of their duties in the field and the office, taken 87 photographs of geological and mining subjects, bringing the total number of negatives now registered up to 789.

In the Annual Report for 1908 reference was made to the transfer of the National Geological Collection to the Survey. In consequence of the passing of the Public Library, Museum, and Art Gallery of Western Australia Act, whereby all property, other than that which was on loan, became vested in trustees, the collection transferred was handed back to the trustees and the Survey specimens rearranged in our own cases, which are at present housed in the mineral gallery of the Western Australian Museum. Three show cases containing the Survey collection of fossils have been lent to the trustees, pending other arrangements being made regarding the housing of the Geological staff and its belongings.

A duplicate collection of about 1,200 minerals and rocks has been presented to the Museum trustees, and arrangements made whereby further duplicates will be donated as opportunity offers.

PUBLICATIONS.

During the past year the following publications were issued to the public:—

Annual Progress Report for the Year 1910.

Topographical Map of Meekatharra.

Bulletin No. 41—The Geology and Ore Deposits of the West Pilbara Goldfield: by H. P. Woodward.

In addition to the above, there are now in the hands of the Government Printer:—

Bulletin No. 42.—Contributions to the Study of the Geology and Ore Deposits of Kalgoorlie. Part I.: by E. S. Simpson and C. G. Gibson.

whilst the following Bulletins, which represent the results of last season's field work, will very shortly be in the hands of the Printer:—

Bulletin No. 43.—Petrological Contributions to the Geology of Western Australia. I.: by R. A. Farquharson.

Bulletin No. 44.—A Geological Reconnaissance of a portion of the South-West Division of Western Australia: by E. C. Saint-Smith.

Bulletin No. 45.—Geological Investigations in the country lying between Latitude 28° and 29° 45' South and Longitude 118° 15' and 120° 40' East, embracing part of the North Coolgardie and East Murchison Goldfields: by H. W. B. Talbot.