GEOLOGICAL NOTES.

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(1) Note on the Laccolites of the Junction Mine, near Mandurama.

The Junction Mine, near Mandurama, has long been famous for the remarkable character of its auriferous deposits. These have been described by previous writers as ore beds, on account of their comparatively low angle of dip and general conformability with the bedding planes of the sedimentary strata, with which at first sight they present the appearance of being interstratified. A recent examination, however, of these deposits by the author in company with Mr. G. A. Stonier, geological surveyor, has convinced him that these deposits are not true ore beds, but laccolites.

Omitting the basalts and their underlying gravels, the author thinks that three distinct varieties of rock are developed at this mine, each probably belonging to a different geological date.

(1) First and oldest are claystones showing remarkable evenness and regularity of bedding, felspathic layers alternating with more siliceous, while on certain horizons are intercalated thin beds of limestone. The author is indebted to Professor W. J. Stephens, F.G.S., for the information that *Pentamerus* occurs in these limestone beds on Mr. Rothery's run, not far from the Junction Mine, and also for the suggestion that continuations of these beds have been replaced by the laccolitic eruptive rocks at the Junction Mine, a conclusion which the author had preconceived before communicating with Professor Stephens, as a result of observing the abundance of calcite in the undecomposed portions of the laccolites, and the occurrence of a small bed of partly silicified limestone at the Belubula Mine, just below the Junction Mine.

(2) Next in age are diorites, which have intruded the preceding rocks in the shape of dykes and laccolites. The diorite varies in texture from crystalline-granular to crypto-crystalline, and in colour from greenish-grey to dark blackish-green. At "The Falls," above the Junction Mine, is probably one of the most magnificent sections illustrative of laccolitic intrusions to be seen in New South Wales. An immense dyke of diorite is here seen to have intersected the claystones almost vertically, and at intervals of from a few inches to about twenty feet it has extended itself laterally along the planes of bedding of the claystones in sheets of from $\frac{1}{8}$-inch to about 20 feet in thickness, and from a few feet to over 100 yards in length. At first sight the precipitous hill-side here appears to be composed of alternate beds of eruptive rock and altered sedimentary strata, at first mistaken by the author for a volcanic series of lavas alternating with fine tuffs. A closer examination, however, convinced Mr. Stonier and the author that these apparent beds were in reality intrusive laccolites, as evidenced by the slightly intrusive character of the junction line of their upper and under surfaces with the sedimentaries, their unbroken continuity with the diorite of the large dyke, the abundance of hornblende in them, and lastly the development of small light grey spots in the claystones near the point of contact, due probably to the formation of chiastolite. In places the laccolites have brought about a partial solution or fusion of the intruded sedimentaries, and where they pass into the so-called ore beds the author thinks they have intruded and replaced probably beds of limestone, absorbing into themselves the lime so as to form a type of rock of an ultra-basic character, for which perhaps the term *Manduramite* may be suggested. This *Manduramite* consists of a coarsely crystalline admixture of calcite and primary hornblende with perhaps some felspar, and abundant magnetic, arsenical, and iron pyrites, with a little copper pyrites. It occurs in lenticular masses from a few feet up to 20 feet thick. The junction line of the Manduramite with the claystone is clearly an intrusive one, the claystone being much bleached and altered into a whitish jasperoid rock at the points

of contact. The oxidation of the laccolites of Manduramite, where they have been brought by denudation within reach of the action of surface-water and the atmosphere, has given rise to the ferruginous masses of material (in places very siliceous, and generally more or less porous from the decomposition of iron and lime) which have been worked for gold for many years past, and which yield from mere traces up to over an ounce of gold per ton. The metalliferous portions of these deposits have probably been derived from metallic solutions in the diorites, which are very pyritous, especially those varieties which contain an abundance of hornblende. A small quantity of the metals present in the ore masses may have been derived perhaps from the replaced limestone.

(3) Next in order and youngest of the three formations are certain dykes of later date than the laccolites, as there is distinct evidence of the former having strongly intruded the latter. This intrusion seems to have exerted a certain amount of segregative influence on the metals present in the laccolites, as Mr. Stonier and the author were informed by the manager, Mr. Hogue, that the ore masses were richer in the vicinity of these dykes than at a distance from them. The micro-petrological character of these newer dykes has yet to be determined.

Conclusions.—The manner in which the intrusive laccolites of diorite have crept along the planes of bedding of the sedimentary rock and absorbed some portions of the claystone, and probably a large proportion of limestone into their substance, is very suggestive as to the possible origin of certain remarkable varieties of rock in New South Wales hitherto classed as metamorphic. It has been asserted by Mr. C. S. Wilkinson, F.G.S., and Mr. E. F. Pittman, Assoc. R.S.M., that at Hill End and elsewhere there occur metamorphic conglomerates containing undoubted water-worn pebbles in a matrix showing freely crystallised felspar. The author also has observed the same phenomena at Vegetable Creek, where a bed of conglomerate can be traced passing by almost insensible gradations into a true eruptive quartz-porphyry, the latter showing

the vanishing outlines of the pebbles of the conglomerate. In the last-mentioned case at all events the author is now confident that the phenomenon is due to the laccolite of quartz-porphyry attacking the conglomerate and dissolving and partly replacing the more fusible portions of it, which would chiefly be its base, whereas its less fusible portions, such as pebbles of quartzite, would still remain unfused, though in many cases completely surrounded by the quartz-porphyry. A further investigation of these metamorphic conglomerates will, the author feels confident, lead in some cases to the adoption of the theory now put forth to account for their origin as being probably nearest the truth.

(2.) Note on the occurrence of *Glossopteris* in a remarkable state of preservation in the Greta Coal-Measures at Richmond Vale near Maitland.

So far as the author is aware, *Glossopteris* has hitherto been met with in the fossil state either in the form of casts or impressions, the original carbonaceous material having completely disappeared, or in the form of carbonaceous material representing the original vegetable matter of *Glossopteris*, but structurally much altered. Recently, however, the discovery has been made of *Glossopteris* leaves, in only a slightly altered condition, in the clay shales of the *Greta Coal-Measures* at Richmond Vale, twelve miles southerly from Maitland. A large shaft has been sunk here by the Richmond Vale Syndicate, which at a depth of about 690 feet (the shaft throughout to that depth being in the Upper Marine Series containing an abundant Permo-Carboniferous Marine Fauna) struck the first of the Greta Coal Seams; at 22 feet (about) below the first seam a bed of grey sandy shale was passed through, $8\frac{1}{2}$ feet in thickness, the upper portion of which contained layers of *Glossopteris* leaves in great abundance. The leaves occur matted together in layers from $\frac{1}{8}$ of an inch to $\frac{1}{4}$ inch thick. Owing to the great pressure to which they have been subjected it is a matter of considerable difficulty to disentangle any individual leaves from

these layers. After prolonged soaking, however, in water, fragments of the clay shale can be so far softened as to admit of individual leaves being separated out. When isolated and mounted on glass slips for the microscope they are seen to be quite translucent, having a reddish-brown colour, and showing their venation very clearly. On some of the leaves dark oval-shaped bodies may be observed, which in one or two cases appear to be symmetrically arranged on the leaves, and may possibly represent fructification. Mr. R. Etheridge, jun., however, after a careful examination of these specimens has come to the conclusion that the evidence on this point is at present insufficient. From the absence of a well defined midrib in some of the specimens, he thinks them allied to *Gangamopteris* rather than to *Glossopteris*. The occurrence of *Gangamopteris* has not, as far as the author is aware, been recorded hitherto from the *Greta Coal-Measures*.

Several of the *Glossopteris* leaves, when *in situ* in the clay shale, were observed to be rolled up longitudinally. This, however, was evidently due to the mechanical action of the water and mud in which they were deposited, for this phenomenon was accidentally imitated artificially by swilling the water gently to and fro in the tub in which the *Glossopteris*-bearing clay shale was being macerated, many leaves which had previously been lying flat, becoming rolled up in the same manner as the natural specimens. It is hoped that a sufficient quantity of these leaves may be obtained for chemical analysis.

Although this appears to be the first recorded instance in Australia of fossil plants occurring in this peculiar state of preservation in rocks so old as the Permo-Carboniferous, similar phenomena have already been observed by the Rev. J. Milne-Curran, F.G.S.,* and Mr. T. Whitelegge.† In the paper referred to Father Curran recorded the discovery by himself of pinnules and leaflets of *Alethopteris* and *Thinnfeldia* in a similar state of preservation to that above described in layers of sandy shale in the Ballimore

* P.L.S.N.S.W., 1884, IX., pp. 251, 252.

† *Ibid.*, 1885, X., p. 62.

Series near Dubbo. This series is considered by Mr. C. S. Wilkinson, F.G.S., and by Father Curran to be probably older than the Hawkesbury Sandstone proper, and perhaps to be the equivalent of the Narrabeen Series, in which case it would probably be of Triassic age. Mr. Whitelegge records a similar occurrence of leaflets of *Thinnfeldia* in a band of carbonaceous clay shale in the Hawkesbury Sandstone at Woolloomooloo near Sydney, a geological horizon probably also referable to the Trias.

(3) Note on the Occurrence of Andesitic Lavas at the Canoblas, near Orange.

At the above locality are the remains of an extremely interesting extinct volcano, which has so far been very little studied. Mr. C. S. Wilkinson made a cursory visit to the Canoblas in the year 1878, and at once concluded from the scoriaceous character of the lavas at the summit of the "Old Man Canoblas," as well as from the great altitude and isolated character of the hill that it had at one time formed a point of volcanic eruptions on a somewhat grand scale. In January of this year, at the meeting of the Australasian Association for the Advancement of Science, a note was read by the Rev. J. Milne Curran, F.G.S., recording the occurrence of a nepheline-bearing basalt, which had evidently flowed from the neighbourhood of the Canoblas, near Orange. The author is not aware of any further published accounts of the Canoblas or of their lavas. Mr. G. A. Stonier, Geological Surveyor, and the author on July 5th last, ascended to the summit of the "Old Man Canobla," by the road which branches from the main Orange to Cargo road at German's Hill.

At a point about $1\frac{1}{4}$ miles along the branch road a bed of thick volcanic tuff outcrops, composed of an ochreous base containing fragments of lava and scoriæ of an andesitic rather than a basic type, together with beautifully perfect crystals of black augite from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in length.

From here to near the summit the road passes over sheets of dense lava rendered porphyritic by crystals of triclinic felspar,

and a few hundred feet below the summit a small sheet of laminated or vertically jointed andesite lava is observable dipping at a somewhat steep angle off the central axis of the mountain. This lava is traversed by such numbers of vertical joints and set so closely together as to present the appearance of being a mass of slate. Microscopic examination, however, proves it to be identical, or nearly so, in composition with the rest of the andesitic lavas of this locality. Its specific gravity is 2·462.

At a point bearing about S. 15°., W. 78 yards distant from the Trigonometrical Station on top of the "Old Man Canobla," is what the author considers to be the central "neck" of the volcano, in the shape of a nearly circular mass of coarsely crystalline and very dense andesitic lava, rising from four to five feet above the general level, and showing strongly marked oblique lamination, the laminæ dipping in towards the centre of the neck at an angle of from 40° to 60°. The neck is about $\frac{1}{2}$ chain in diameter, and is surrounded by beds of scoriaceous lava to the north and scoriæ to the south. The beds of the former to the north dip northerly at about 15°, and are overlaid by a dense flow of lava, on the highest point of which the Trigonometrical Station now stands.

South of the neck the beds of scoriæ dip first northerly towards the neck, then qua-qua-versally chiefly from west towards south at an angle of from 20° up to 40°, as far as the western edge of the mountain, where the scoriæ pass into a coarse volcanic agglomerate composed chiefly of large pieces of cellular andesitic lava. The southerly dip here probably represents the dip of the beds on the outer slope of the old crater, while the northerly dip towards the neck represents the crater-ward dip.

A curious semi-circular hollow floored with dense lava is observable a few chains south-south-westerly from the Trigonometrical Station, but in the present denuded state of this ancient volcano it is difficult without detailed mapping to ascertain its exact relation to the central neck

Only a few sections of these lavas have as yet been microscopically examined by the author. They appear to be closely related to the copper-bearing andesitic lavas of Kiama, which, as will be described in a subsequent note, are probably of Permo-Carboniferous age. Some of the older lavas which have emanated from the Canoblas, are also copper-bearing, as at the copper mine near Walli.

The Pinnacles, a mammillated hill about one mile northerly from the "Old Man Canobla," probably marks the site of a parasitic cone