ON SOME IGNEOUS ROCKS FROM THE HEAZLEWOOD DISTRICT.

By W. H. Twelvetrees, F.G.S., and W. F. Petterd, C.M.Z.S.

Read July 12, 1897.

The Heazlewood District is situated directly south-west of the township of Waratah, in the county of Russell, and has of late years been made fairly accessible in consequence of its importance as an active centre of mining industry. The geology is in several respects unlike that of any other portion of the island, as far as known; though no systematic investigation of it has yet been undertaken. It lies south of the great coastal basaltic sheet, and north of a series of ancient metamorphic schists, with the interpolated gneisses and masses of crystalline limestone of the Pieman River area. Geologically, its characteristic features may be said to commence at a locality situate on the main Waratah-Corinna road, and known as the 10-Mile, and to continue thence to the immediate neighbourhood of the 18-Mile Camp. It extends in a northerly direction a small distance beyond Mt. Cleveland, and is crudely bounded on the south by the Parsons' Hood Mountain, with an irregular interruption by the stanniferous granites which form the main feature of the Meredith Range. The characteristic which renders the area of special interest to the geological student, and to the petrologist in particular, is the occurrence of a series of local rocks, which include fine grained granitites and syenites with masses of serpentine, the latter being closely associated with gabbros and ultra-basic rocks. These last commonly appear as comparatively large intrusive dykes. Rocks of the diabase and altered andesite families also occur, but are by no means numerous. The granitites and syenites usually form bosses of medium altitude, embracing and forming the boundary lines of the intrusive serpentinised rocks, which are remarkably pronounced on both sides of the Heazlewood River. The gabbros are of several distinct types, and often have their essential mineral constituents preserved in a very fresh condition, although there is conclusive evidence that in at least one instance the serpentine has originated from the alteration of such a rock. In the limited class of ultra-basic rocks we find a most attractive and varied series, such as is rarely offered for petrographical investigation. These range through the true peridotites to the varied mineral aggregates of the pyroxenite family. In some instances only one of the two crystal systems is present, but occasionally the rock contains both the rhombic and monoclinic pyroxenes. In this group also a considerable variation is noticeable in the state of

preservation; in some cases a pronounced chemical change has occurred, whilst in others the rocks are in a perfectly unaltered condition; thus furnishing strong evidence in favour of their intrusion at a later geological epoch.

The sedimentary rocks are not extensively represented, so far as observed. They consist of three distinct superimposed beds, which are fairly well exposed in parts of the Bell's Reward mine. The lower bed apparently rests mainly on the granitoid rocks as a pale-coloured non-fossilised limestone of some irregularity; on this is a bed of sandstone in which no fossils have been found. The whole is surmounted by a layer of sandstone containing the casts of numerous testacean remains, which show this formation to be of silurian age. Occasionally, in other parts of the district, argillaceous rocks are met with, but they are almost invariably of limited extent.

On account of the readiness with which many of the less acidic rocks of the Heazlewood disintegrate and form soil, it is often a most difficult matter to make a satisfactory examination, and it is thus needless to say that much work remains for the field geologist, both as regards the relationship and mode of occurrence of the rocks of both igneous and sedimentary origin. This difficulty is further augmented by the dense, in places almost impenetrable, nature of the vegetation. In many localities, more especially on the banks of the numerous small streams, there exists a somewhat heavy overburden of tertiary sands, gravel, and clay, which, in favourable places, have been extensively worked for alluvial gold.

The series of rocks herewith described by no means exhausts the petrological wealth of the Heazlewood, but an endeavour has been made to present a fairly representative series, taken from the rocks exposed by the construction of the Waratah-Corinna road traversing the district. These have been further increased by samples collected from several of the silver-lead mines visited by one of the authors, and by specimens received from the veteran prospector, Mr. W. R. Bell.

1. Harzburgite.

Harzburgite: Rosenbusch, Massige Gesteine, 1896. *p* 355.

Saxonite: Wadsworth. Lithological Studies, 1884. *p* 85.

Sp. Gr. 3·21.

This is a typical peridotite, composed of olivine and enstatite, harzburgite in accordance with the nomenclature of Rosenbusch. Such rocks are not usually met with in

large masses: they shade off into felspathic rocks, becoming enstatite—olivine—gabbro—olivine—norite, and even among themselves they appear to be subject to much local variation in one and the same mountain mass. It is unusual to find them in such a fresh condition as on the Arthur River. The saxonite of the Red Hill, West Coast, New Zealand, containing the nickel-iron alloy awaruite * is said to be the only other occurrence in the world where the rock is fresh or nearly so: generally it is strongly serpentinised. Olivine—enstatite rocks have been described from the Straits of Magellan, Borneo, Oregon (nickeliferous), Greenland, Finland, Norway, United States, and the Hartz.

Macroscopical Structure.—This is a characteristically heavy, somewhat dull and dark-coloured rock, in which the brown, waxy olivine is the predominating feature: occasional and fairly distinct plates of the rhombic pyroxene may be detected, but to the eye they do not appear to be by any means abundant. It occurs as a dyke of limited extent at the upper Arthur River (W. R. Bell). The structure is hypidiomorphic granular. Rosenbusch calls a structure granular, in which only one generation of the constituents exists, no recurrence of phase having taken place, and hypidiomorphic when mostly allotriomorphic and partly crystalline forms prevail.

Microscopical Appearance.—Olivine forms nearly one-half of the rock. In transmitted light this mineral is colourless and remarkably fresh in appearance. Still it is traversed by fissures, sometimes darkened with the deposition of some iron oxide, or filled with yellow serpentine. The olivine grains are sometimes rounded, but often show a marked disposition to form idiomorphic crystals.

Enstatite is generally in somewhat larger forms than the olivine; is colourless and non-pleochroic in thin sections, but where the section is thicker, it is faint yellow and feebly pleochroic. As a rule its cleavage cracks serve to distinguish it from the olivine, and in the larger crystals the forms are less perfect than those of the other mineral. It encloses small intergrowths of a monoclinic pyroxene. It is in a fresh condition while the olivine is frequently meshed with serpentine, and sometimes wholly replaced by it.

Magnetite is not so prevalent in peridotites as chromite or picotite, but we see no translucent forms, and hence refer the scattered rounded quadrate and other opaque grains to magnetite. At any rate we see none of that translucency at the edges which would indicate chromite or picotite.

* On the discovery, etc., of Awaruite on the West Coast of the South Island of N.Z., by Prof. G. H. F. Ulrich. Q. J. G. Soc., Nov., 1890, p. 619, 632.

2. Olivine-Norite.

Olivine-Norite : Rosenbusch.

Hyperite : Törnebohm.

Sp. Gr. 2·90.

The rocks of deep seated or plutonic origin, of a coarse grained granitoid texture, composed of a basic plagioclase felspar, and the laminated augite called diallage, with or without olivine, are known as gabbros. In addition to, or in place of, the diallage, common augite is sometimes met with, without, however, affecting the name of the rock. Further, the monoclinic pyroxene is occasionally replaced by a rhombic one, and when this happens we have norite. At the same time gabbros exist, in which both the rhombic and monoclinic forms of pyroxene occur, and this tends to show that the line separating gabbros and norites is not a sharp one. Still it is the habit of modern petrographers to reserve the name norite for those gabbros in which the pyroxene is solely or mostly rhombic. Olivine-norite is the hyperite or hypersthenite of Norwegian geologists. It has also been recorded from Finland, France, Austria, Canada, United States, Sumatra, and Madagascar; always associated with gabbros. It does not appear to occur in Britain.

The macroscopical appearance of this rock is perfectly fresh; it shows a somewhat compact but coarse granitoid structure from the closely embedded plates of pyroxene. In colour it is a mottled dark greenish black. The pyroxene is the darkest coloured constituent, it being almost black, with a glimmering surface; the interspaces which are occupied by the felspar and olivine are of much finer texture, rather dull and pale green in colour. It is found forming a mass of considerable extent associated with the serpentine and augite-syenite of the district.

Microscopical Appearance. — Its texture is granitic, that is to say, the free crystallisation of the constituent minerals has been interfered with mutually, and the forms (with the exception of the olivine) are those of broad irregular plates. The component minerals in order of importance are bronzite, plagioclase felspar, olivine, a little monoclinic pyroxene, and titaniferous iron oxide in grains.

Rhombic Pyroxene.—The irregular ophitic plates of this mineral have no tendency to idiomorphism. It is light brown to bronze in colour with slight pleochroism where clearest, markedly pleochroic where the lustre is most bronzy. The striation resembles that of diallage, but the straight extinction and pleochroism distinguish it. The interference colours between crossed nicols are of a lower order than those of monoclinic pyroxene. Enstatite proper is

theoretically non-pleochroic, bronzite slightly so in the slices usually prepared for the microscope. The colour, pleochroism and enclosures, point to the mineral being the ferriferous enstatite called bronzite. The boundary between enstatite and bronzite is vague: there has been great divergence of opinion as to what constitutes enstatite and what bronzite. Professor Rosenbusch † unites them, while preserving their separate names. Generally enstatite is applied to the non-ferriferous and bronzite to a ferriferous variety. In the rock from the Heazlewood the colour and pleochroism which are sometimes relied upon as distinguishing characters ‡ vary even in the same plate. It will suffice, however, if we assign to this mineral the name bronzite. Everywhere it encloses rounded serpentinised grains of olivine, and has familiar interpositions, consisting of lamellar intergrowths of monoclinic pyroxene. In some places it is in course of change into its serpentinous modification, bastite, in which there is some general approach to parallelism of the fibres, quite distinct from the open meshed arrangement of the serpentine in the olivine crystals.

Felspar.—This is abundant in the broad forms usual in gabbros. The albite plan of twinning prevails and the extinction angles exceed 40°, pointing to anorthite. The pericline type of lamellations, traversing the albite twinning lines, is also observable. The felspars often not only penetrate the pyroxene, but are to be seen occasionally wholly included in its substance. They frequently enclose olivine grains, and consequently the order of consolidation of the three constituents of this rock is very plainly revealed. They are often traversed by cracks filled with serpentine proceeding from included and adjacent olivine grains, but whether the felspathic substance itself has been attacked and serpentinised is doubtful. On the theoretical possibility of this see Teall, British Petrography, p. 107.

Olivine.—This appears to have been the first mineral to separate, and it occurs chiefly in the form of rounded grains, sometimes in nests, but also scattered abundantly through the rock. This mineral is always meshed with serpentine, and is enclosed in the pyroxene and felspar, the latter also being often embraced by the bronzite. It illustrates the lustre-mottling structure in a very striking way. The olivine is colourless, the serpentine reticulations pale green and greenish yellow, and their course is often indicated by magnetite grains. The fibrous serpentine forming the meshes polarises faintly and extinguishes at 90°. The cracks in adjoining crystals, due to expansion, caused by the serpentinisation

† Mikroskopische Physiogr: der Petrogr. wichtigen Mineralien, 1892, p. 449.

‡ Hatch. Intr. Study of Petrology, 1891, p. 43.

process, are well seen, and recall the well-known appearances in the troctolite of Volpersdorf. Where the olivine has been completely serpentinised, the resultant substance is inert on polarised light.

3. Pyroxenite.

Sp. Gr. 3·10.

This rock is exclusively a pyroxene; it contains no olivine, and consequently comes within the group pyroxenite, as established by Dana in 1880. Pyroxenites are considered as intimately related to the gabbro family; and as peridotites are ultra basic olivine representatives of gabbro, so we may call these pure pyroxene rocks the olivine-free ultra basic members of that family. They vary greatly, and the varieties have been classified by G. H. Williams as websterite, bronzitite, hypersthenite, diallagite. The Heazlewood rock appears to occupy an intermediate position between the first two divisions. Websterite typically consists of a rhombic pyroxene and augite (or diallage) in equal quantities, but varies into bronzitite or hypersthenite by losing its augite, or, on the other hand, the rhombic pyroxene disappears and the rock becomes diallagite. Our rock in thin section shows nearly exclusively large crystal faces of enstatite, accompanied sometimes by a more ferriferous variety (bronzite) with characteristic wavy cleavage lines and bronzy lustre. There is, besides, a small quantity of laminated augite. What is known as the mortar structure may be seen, which is very common in this type of rock. The large crystals are separated from each other by a channel filled with as breccia of small crystal fragments of enstatite, a colourles non-striated augite (diopside?), and sometimes with brightly polarising talcose matter, which has infiltrated by cracks into the substance of the large enstatites. The development of this structure is due to rock crushing, and the appearance of talc is a frequent feature in altered pyroxenites. The rock is evidently a passage one between websterite and bronzite.

Macroscopically the rock is seen to be composed of closely packed lamellar crystals of considerable size; those of the principal essential, enstatite, sometimes reaching several inches in length and proportionate width. In colour the mass of the rock does not vary to any material extent; it is in a general way of a greyish green to pale brown hue, with occasional patches of a fairly bright green. The uniform lustre is silky, vitreous, and slightly metalloid, but when individual crystals are exposed parallel to the face of the rhombic prism they are usually highly polished, and this character lends itself to add to the peculiarly attractive appearance of the mass. The rock is very tough under the hammer, with a hackly fracture when broken across the embedded crystals. The interstices sometimes show bright

green specks (chrome diopside ?), and still more rarely patches of a talcose substance. In weathering the exposed surface becomes a dull yellowish brown, which does not penetrate deeply into the mass of the rock. This pyroxenite occurs exposed in the road cutting on the sideling across the Bald Hill, immediately west of and close to the bridge across the Heazlewood River on the Waratah-Corinna Road. The eastern portion of the road is apparently mainly, if not entirely, composed of the rock, but its extension north and south has not been traced. It is probably an intrusive of considerable extent.

4. Augite-Syenite.

Sp. Gr. 2·84.

This is a plutonic rock of the intermediate group, in which there is very little free quartz. The primary constituents are orthoclase plagioclase, augite, hornblende, biotite, quartz, secondary quartz, chlorite.

Macroscopical Structure.—A somewhat handsome rock of a comparatively fine granitoidal structure. It forms a thoroughly crystalline mass, although the crystals of the predominating essential minerals cannot be distinctly outlined by the unassisted vision. It presents a remarkable resemblance to many gabbros, and might readily be mistaken for such, if not carefully examined. It has an evenly distributed mottled apperance on the surface of a fresh fracture, and for a syenite is unusually dark in coloration. The prevailing tint of the ground mass is a pale greenish-white, with numerous extremely irregular and closely packed blotches of a dull greenish-black, but with an occasional minute area of reflecting lustre. The exposed portions of the rock are much weathered to a dull greyish-white. As might be anticipated with an intermediate rock of its nature, it is hard and tenacious. It occurs as an eruptive mass of apparently restricted extent, which forms portion of an abrupt hill of medium elevation near the workings on the Bell's Reward Silver Mine. Associated with it is a fine-grained hornblende granitite, the whole being mainly flanked by the sandstone and limestone of the locality, together with the serpentine-gabbro rocks so abundant in the district.

Microscopical Structure.—The predominating felspar is orthoclase in simple tabular forms and carlsbad twins; a soda-lime felspar is present in considerable quantity, with the extinction angles of oligoclase-andesine. The felspars are turbid in their interiors, with the usual kaolinisation products, but the peripheral parts often remain perfectly clear and transparent. The augite is pale green, often twinned parallel to the orthopinacoid, with a second lineation parallel

to the base. Basal sections give unequal octagonal forms: sometimes idiomorphic, sometimes allotriomorphic, in relation to the felspar. It is fairly abundant. Biotite is represented by green chloritic pseudomorphs, and a few outlines are those of hornblende.

5. Lherzolite.

Sp. Gr. 2·93.

This is another rock belonging to the varied peridotites which are found at the Heazlewood. The mineral combination is olivine + enstatite + monoclinic pyroxene, and it has been called Lherzolite after the lake Lherz in the Pyrenees. Of these three minerals, olivine greatly preponderates, and it is not difficult to imagine the pyroxene failing entirely, and a dunite or purely olivine rock to result. The rhombic pyroxene is the only other constituent present in any quantity, for there is very little monoclinic pyroxene indeed. The structure is hypidiomorphic-granular, and both pyroxenes and olivine are reticulated with serpentine meshes. Olivine grains are often enclosed in the enstatite, and there is no approach in the latter to hypersthene. The augite resembles the diallagic variety rather than diopside, and neither pyroxene is serpentinised to the same extent as the olivine. There is some chlorite in the rock, besides grains of magnetite (?) and wisps and meshes of titaniferous iron, and its alteration product, leucoxene.

This is a close textured rock, without any striking peculiarity. It is greyish green in colour throughout in the solid portions, but where slight fractures occur, a dark green, almost black, tint prevails, with a slight glaze, otherwise the mass is dull in general appearance. It occurs in the form of an intrusive dyke of restricted dimensions at the 10-Mile, Waratah-Corinna Road.

6. Websterite.

Sp. Gr. 2·82.

Mineral Composition, Diallage and Enstatite.

Websterite, as established by G. H. Williams, is a pyroxenite, consisting of monoclinic and rhombic pyroxenes. These are the constituents of the Heazlewood rock, the augite being predominant. In parts it consists of long prismatic forms, which have not been attacked by serpentinising agencies: elsewhere it seems to have formed somewhat larger diallagic plates, which are nearly wholly replaced by serpentine. It is difficult to determine precisely whether olivine in small quantity was present, as the serpentinisation of the rock has obscured its original facies. The enstatite is not abundant, and it is mostly enclosed in and intergrown with the diallage.

Leucoxene may be detected in patches, and a little chlorite occurs here and there throughout the sections.

At the Heazlewood, extensive masses of serpentine occur of comparatively limited width. These have a considerable extension in a northern and southern direction. It is of common occurrence for several miles north of the main Waratah-Corinna road, and has been traced as far south as the Parson's Hood mountain. With it numerous varieties of olivine and pyroxene-bearing rocks are intimately associated, from the alteration of which the serpentine doubtless originates. In the immediate neighbourhood of the Heazlewood S.M. Co.'s property, the rock now under consideration—websterite—is extremely abundant, occurring in protruding masses of somewhat large size, and apparently in places passing into a more pronounced serpentinised form. When met with in a fairly fresh condition, it is extremely dark in colour, almost black, with an occasional green tinge. The lustre is dull and obscure, except for the occasional large patches of diallage, which have a glimmering surface. On weathering, the outer crust is invariably very irregular, with numerous sharp, jagged protuberances, the whole surface then becoming of a dark brown colour.

7. Granitite.

Sp. Gr. 2·68.

Granitite, or as it is sometimes called biotite-granite, generally carries some hornblende, but that mineral does not appear to be present in this rock. In general macroscopical appearance this is a granular and compact rock of somewhat even texture, without any of the essential mineral constituent-becoming porphyritically developed. In colour it is yellowishs white, intermixed with dull green, the first mainly arising from the felspars, and the latter from the abundant chlorite it contains. On the exposed surface it is coated with a thin crust of a rusty hue, which does not penetrate deeply into the solid rock. It occurs in considerable quantity in intimate geological association with the augite-syenite herewith described, and with it forms the principal mass of the higher elevations on the Bell's Reward Silver Mine and the immediate vicinity, apparently running parallel with the serpentine rocks. It is one of the many varieties of rock that have been generally termed "diorite" in this colony, and more rarely "greenstone," its true petrological nature having apparently escaped detection.

Min. Constit.: Orthoclase, plagioclase, biotite, quartz, sphene, magnetite, chlorite.

Microscopical Appearance:

Orthoclase in irregular forms, sometimes graphically inter-

grown with quartz: prevailing forms columnar Carlsbad twins.

Plagioclase in some quantity, but less than orthoclase. Generally in short stout idiomorphic prisms. Extinction angles, those of oligoclase-andesine.

Biotite represented by pseudomorphs of a green pleochroic mineral, polarising in the steel grey tints of chlorite. This chlorite is also plentifully distributed throughout the rock in aggregations, and between the boundaries of the felspars.

There is not quite so much quartz as in normal granites: a little sphene occurs in grains, and magnetite in grains and crystals.

8. Hornblende Granite.

Min. Const.: Orthoclase, plagioclase, hornblende, quartz, sphene.

Sp. Gr. 2·7.

Nearly two miles north-west of the main road, and near the south bank of the Heazlewood River, is a small boss of this holocrystalline rock. It projects but a few feet above the level of the surrounding country, which is mainly serpentine, of the usual character common to the district. So far as known it is exceptionally local in its occurrence.

Macroscopical Character.—In general features this granite bears a strong resemblance to its congeners, being dense and compact. The exposed surface is but slightly decomposed to a thin incrustation of kaolinic matter of a pale rusty tint. The colour of the ground mass is light grey, approaching white, with indistinct cloudings of a somewhat darker hue. Throughout the substance of the rock are scattered irregular elongated flakes of hornblende, which appear black to the unaided vision. These give it an obscure graphic appearance. Small patches of copper and iron pyrites may be frequently detected, which decompose to rusty stains.

Microscopical Structure.—The quartz is intergrown very generally with the felspars, especially with the triclinic ones, in a micrographic way. The hornblende is usually without terminal outlines, and pale green in colour, preserving its pleochroism, but not intensely. Crystals of sphene are present in the usual forms. There is some tendency to a micro-porphyritic architecture, small prisms of orthoclase and plagioclase, especially the latter, abounding as a kind of ground mass. Small grains of ilmenite may be seen scattered throughout the section, and this is often converted into the white variety of sphene named leucoxene, as may be seen by changing the transmitted light to reflected, when the black iron mineral becomes white.

9. Hornblende Granitite.

Min. Const. : Orthoclase, plagioclase, biotite, hornblende, quartz.

Sp. Gr. 2·9.

Macroscopical Characters.— The general ground mass of this rock is of a pale greenish grey colour thoughout, with but slight variation of tint. It has a perfectly fresh appearance, although dull in lustre. The abundant magnesian mica forms a strong contrast to the general colouration, being an extremely dark green, approaching black, with a glimmering surface on the basal cleavages. It usually occurs in aggregated bunches with occasional comparatively large flakes. The hornblende is also dark in colour, but it may be detected here and there by its longitudinal striation. Of the several varieties of granitite which have been observed in this district, that under notice is not only the coarsest in general structure, but is also the most conspicuous in colouration. It was obtained on the higher ground near the 14-Mile Camp, associated with the augite-syenite.

Microscopical Structure.—The dominant coloured constituent is biotite, a green hornblende being quite subordinate. Hence we can hardly call the rock a hornblende-granite. As granitites (biotite-granites) do not always carry biotite exclusively, they may vary into hornblende-granitites, and often contain a good deal more hornblende than the present rock. There is a fair quantity of quartz and oligoclase-andesine felspar with albite twinning. Plates of orthoclase, optically continuous, sometimes enclose crystals of plagioclase snd biotite. The mica is in irregular disjointed plates and shreds, often bent and wavy, in colour deep brown, bleaching to bronze and pale greenish yellow, retaining always strong pleochroism.

10. Gabbro without Olivine.

Min. Const.: Diallage, enstatite, plagioclase felspar, titaniferous iron.

Sp. Gr. 2·88.

Macroscopical Structure.—This is a dense crystalline granular gabbro without any marked external peculiarities. It is uniformly dark in colour ; the ground mass of the rock is grey, with greenish-black irregular markings plentifully distributed throughout its substance. It occurs in masses of considerable extent in close proximity to the serpentine belt, and is associated with some of the pyroxenite rocks.

Miscroscopical Structure. — A holocrystalline gabbroid aggregate of pyroxene and felspar. The diallage pre-

dominates, but there is much serpentinised enstatite. The diallage is present in too great quantity for the rock to be a norite, but the rhombic pyroxene stamps it as a passage rock between the gabbros proper and norites. The felspar is not plentiful, and from its high extinction angles may be assigned to the anorthite group. Some of the crystals of felspar show incipient decomposition in the form of opaque dusty patches, which is probably the commencement of saussuritisation. The titaniferous iron is granular, and in the state of leucoxene. No olivine is visible.

11. Porphyritic Diabase.

Min. Const.: Augite, plagioclase felspar, magnetite, and secondary chlorite.

Sp. Gr. 2·9.

Macroscopical Structure.—A fine grained, compact rock, presenting a uniform dark grey colour throughout, with the exception of the porphyritic crystals of triclinic felspar, which are milk white and shining on the principal cleavages. The numerous porphyritic felspars form the most conspicuous feature of this peculiar diabase. They occur semi-distant and irregularly embedded; in size they vary in a marked degree, the majority probably averaging about 8 millimetres in length, with an occasional specimen of comparatively large size. Under the hammer this rock is exceedingly tough, breaking with an irregular sharp-edged fracture. It was observed in the form of loose blocks on the Waratah-Corinna road, near the bridge which spans the Arthur River. As it was not obtained *in situ* it is uncertain whether it is effusive or a penetrating mass.

Microscopical Structure.—Its main feature is the marked development of the diabasic or ophitic structure, the large shapeless masses of augite looking as if cut up by narrow felspar prisms in all directions. The orientation, however, remains the same, showing the pyroxenic substance to be one and the same crystalline mass. This division of the augite is essentially an optical effect; in reality, the felspars had crystallised out in their present form before the augite had consolidated. When it did consolidate, it enwrapped the felspars, which then remained fixed in different positions. The latter is now pale green in tint, and all of it is in a chloritised state.

Another noticeable point is the presence of a few large crystals of plagioclase felspar, imparting a porphyritic appearance to the rock. This is what Rosenbusch calls the diabase-porphyrite facies. It is often connected with the peripheral parts of diabase intrusions. Notwithstanding this, the rock

is holocrystalline, the rest of the field appearing to consist of smaller felspars and augite, and feathery chlorite after augite. This rock in its primitive state was an ophitic dolerite, but it has undergone a thorough chloritic alteration. The term diabase in Tasmania, as elsewhere, should be reserved for such occurrences, and not applied to comparatively fresh rocks like the mesozoic dolerite of Launceston.

12. Websterite.

Sp. Gr. 2·94.

This is a second type of websterite, a species of the plutonic group of distinctly pyroxene rocks, of which several peculiar varieties occur in the Heazlewood district. They form, in conjunction with other members of this group, one of the most characteristic features of the locality. They are almost invariably intimately connected with the serpentine area, and consequently soon attract attention. That at present under consideration has a strongly holocrystalline granular structure throughout. The enstatite is readily discernible scattered throughout the substance of the rock in the form of translucent laminæ of a yellowish-brown colour, which have a pseudo-metallic lustre, in this respect closely resembling its ally bronzite. The more plentiful monoclinic diallage is apparently of a darker tint, with little or no pronounced lustre.

The two forms of pyroxene are closely packed together, so that they give the fractures a distinctly roughened surface by the projecting angles of the numerous crystals. The embedded individual crystals of both pyroxenes are fairly uniform in size, rarely exceeding 5 millimetres in length, and are entirely without the scattered large flakes of diallage which form such a pronounced feature in the variety of websterite already described. This rock is sometimes found to enclose elongated, crudely lenticular blocks of perfectly serpentinised material of an intensely black colour; these often reach a considerable size, which then tend to give the mass a brecciated appearance. It is often met with in a partially decomposed condition, in which case the components are more readily reduced to powder, and the general appearance of the rock is considerably altered. In this condition it becomes of a dull greenish-brown colour, with here and there thin patches of ferrous oxide, and has occasionally an indistinct fissile structure. On weathering, the exposed surface of the rock generally becomes of a dark rusty brown colour.

Microscopical Structure. That of a pure pyroxenite, being solely pyroxene, mostly monoclinic in elongated forms accompanied by enstatite in sufficient quantity to rank it as the

websterite of Williams The diallage is made up of lamellæ, orientating optically in different stripes, and the crystals have sometimes been mechanically bent into deformed curves. The enstatite is in squarer forms, much serpentinised and in parts altered into bastite.

13. Enstatite Porphyrite.

Sp. Gr. 2·84.

Min. Const.: Chloritic pseudomorphs after enstatite, augite, felspar in a ground mass of felspar laths and quartz, magnetite in vesicles, quartz, calcite, epidote.

Macroscopical Structure. In general appearance this is a dull, greenish-grey coloured and finely granular rock, with numerous distinct but minute pittings of a darker, almost black, shade scattered throughout; these are apparently the chloritic pseudomorphs after the pyroxenic constituents. These markings are, although usually plentiful, more pronounced in some samples than others. The most noticeable feature in this rock is its highly vesicular character throughout. The vesicles vary from small cavities, which are scarcely discernible to the naked eye, to others which reach a comparatively large size, occasionally measuring from two to three inches in diameter. They are almost invariably lined with a thin coating of colourless shining secondary calcite, many of the larger ones being quite filled with this substance. There is sometimes a rather large quantity of dark coloured epidote in fibrous fan-shaped aggregations in close association with the calcite. This porphyrite is fairly hard and tough, breaking with a hackly fracture. The exposed surfaces are usually weathered to a pale rusty brown. It occurs in the form of an intrusive dyke, which is apparently about two chains in width, as seen exposed by the road cuttings near the 11-Mile Peg on the Waratah-Corinna road. In the near vicinity are rocks of sedimentary origin, but now much altered, and mainly represented by cherty quartz.

Microscopical Structure.—Nearly all the phenocrysts have been converted into chlorite of a pale greenish hue, slightly pleochroic, and giving a blue slate interference colour. From their forms we judge the original minerals to have been, in their order of frequency, enstatite, augite, felspar. In one instance one of the porphyritic felspars has resisted the process of change. Its extinction angle is moderate: it is probably labradorite. The enstatite crystals are entirely idiomorphic, of prismatic habit and often cross jointed. From these tranverse fissures and from the margins the

change to bastite is in process, very visible by polarised light. The crystals of augite are much fewer in number, and are mostly somewhat octagonal in section.

The felspar of the ground mass comprise striped and simple laths, and often show fluxion phenomena. The small extinction angle of the twinned felspars points to oligoclase, and the straight extinctions of the simple laths to orthoclase. There is a quantity of granular quartz in the ground mass, but it is doubtful whether all of it is primary. If it is, it is rather an exceptional occurrence in enstatite-porphyrite. The rest of the ground mass consists of diffused chloritic matter and brown granular apparently micro-felsitic substance. Large amygdaloidal cavities are occupied by quartz, epidote, and calcite. Here and there in the ground mass, especially in the neigbourhood of the amygdaloids there are aggregations of granular magnetite, obscuring the felspar microliths, but little or none elsewhere. The rock evidently belongs to the intermediate division, and is essentially andesitic.

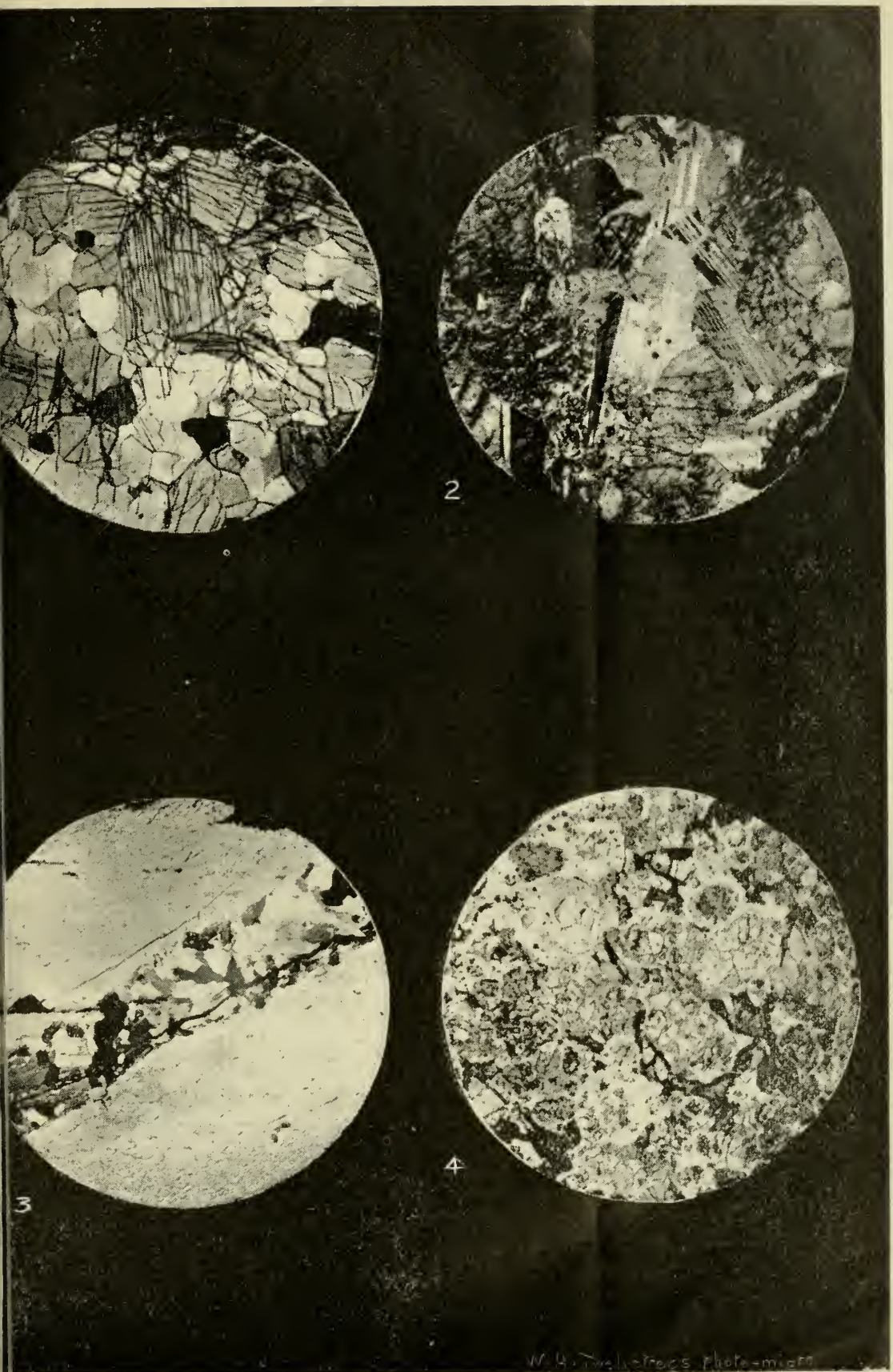
EXPLANATION OF PLATE.

FIG. 1. Harzburgite. × 13. Crossed Nicols. The larger crystals are enstatite. Most of the smaller ones are olivine.

FIG. 2. Olivine Norite. × 13. Crossed Nicols. Shows polysynthetically twinned felspars and meshed olivine. The dark parts are principally enstatite.

FIG. 3. Pyroxenite. × 18. Crossed Nicols. The field is occupied by part of large diallage crystals, separated by a brecciated vein of small crystals of monoclinic pyroxene, the "mortar structure" of petrography.

FIG. 4. Lherzolite. × 13. Crossed Nicols. Shows the granular association of olivine and pyroxenes. This is No. 5 in the paper.



HAZLEWOOD ROCKS.