Art. LXXII.—*Notes on the Mineralogy of New Zealand.*

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The work of the Geological Survey naturally divides itself under various heads, to each of which one officer or other of the department devotes special attention, and it has fallen to my lot, while pursuing the general routine work of the survey, to be more especially connected with the mineralogical and mining branches than with any other.

This being so, Dr. Hector has suggested that it would be of interest to bring before the Society in a connected form the details which have been collected from time to time concerning the minerals hitherto discovered in New Zealand, and I propose to make the present paper the first of a series describing the New Zealand minerals, with such points of interest concerning them as suggest themselves to me, and I hope that where members have information of minerals existing in localities which I do not cite, they will be good enough to furnish the Society with notes of the same, as any description of this sort should be as complete as it is possible to make it.

Up to the present time the accounts of the minerals found in New Zealand have been somewhat fragmentary. In 1865, Dr. Hector published a list of the minerals found in the province of Otago, together with a description of the same in the "Jurors' Reports of the New Zealand Exhibition," 1865; and this description was very complete when it is considered that at that time the Geological Survey of New Zealand had hardly commenced. Since that time Professor Hutton has published a list of Otago minerals in his report on the geology of Otago, which does not include all the specimens mentioned by Dr. Hector. Professor Liversidge has also (Trans. N.Z. Inst., vol. x., p. 490) described a selection of minerals forwarded to him, and Professor v. Haast has mentioned some of the economic minerals found in Canterbury in his work on the geology of Canterbury and Westland, besides which the Colonial Museum and Laboratory Reports and the Geological Survey Reports contain mention from time to time of minerals forwarded for identification or collected by the Survey, but none of these are complete in themselves, so that I think there is sufficient reason for a work of this sort.

The system of classification which I propose to pursue is the one adopted by Professor Warrington Smyth, of the Royal School of Mines, London, and it is on this system that the minerals in the Colonial Museum have been arranged. This is as follows:—

METALLIC MINERALS.—Class I.

Brittle and fusible with difficulty.

Titanium	Chromium
Tantalium	Uranium
Tungsten	Manganese
Molybdenum	Columbium.

METALLIC MINERALS.—Class II.

Brittle, easily fusible an l volatile.

Arsenic	Tellurium
Antimony	Bismuth.

METALLIC MINERALS.—Class III.

Malleable, not reducible by heat alone.

Zinc	Cobalt
Cadmium	Nickel
Tin	Iron
Lead	Copper.

METALLIC MINERALS.—Class IV.

Noble metals, reducible by heat alone.

Gold	Silver
Platinum	Iridium
Mercury	Osmium, etc.

NON-METALLIC MINERALS.—Class I.

Water.

NON-METALLIC MINERALS.—Class II.

Carbon and Boron.

NON-METALLIC MINERALS.—Class III.

Sulphur and Selenium.

NON-METALLIC MINERALS.—Class IV.

Haloids and Salts } Salts of Ammonia, Potash, Soda, Baryta, Strontia, Lime, Magnesia, Alumina, Yttria, and Ceria.

NON-METALLIC MINERALS.—Class V.

Earths.—Silica, Alumina, Magnesia, and their hydrates.

NON-METALLIC MINERALS.—Class VI.

Silicates and Aluminates. }
- Silicates of Magnesia and Lime, hydrous and anhydrous.
- Silicates of Alumina, hydrous and anhydrous.
- Aluminates of Magnesia and Glucina.
- Silicates of Glucina, Zirconia, Thoria, and Yttria.

The present paper will be devoted to the metallic minerals.

METALLIC MINERALS.—Class I.

Brittle and fusible with difficulty.

TITANIUM.

Brookite, $\ddot{\mathrm{Ti}}$.—The occurrence of this mineral in a trap-rock (coarsely crystalline dolerite, belonging to the upper cretaceous period) at Otepopo, discovered by Dr. Hector in 1862, is mentioned in the Jurors' Reports of the New Zealand Exhibition, 1865, p. 264. No specimens are in this Museum, and Professor Liversidge does not mention it in his description of the New Zealand minerals in the Otago Museum submitted to him for examination by Professor Hutton.

Ilmenite, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\mathrm{Ti}}$.—This mineral is represented in the iron-sands of New Zealand, which contain variable quantities of Titanic oxide, but it more properly belongs to the ores of iron, under which it will be described.

Titanium has not up to the present time received any useful application in the arts, indeed all its properties appear to act deleteriously. Associated with iron, as in the well-known Taranaki iron-sand, it renders the ore so refractory as to make it practically useless, and in Norway and Sweden, where vast deposits exist in readily accessible places, they are unworked, although the ore could be placed in the English market for as little as 10s. per ton.

TANTALIUM.

This metal has not yet been discovered in New Zealand.

TUNGSTEN.

Scheelite, $\dot{\mathrm{C}}\mathrm{a}\ \dddot{\mathrm{W}}$.—The occurrence of this mineral in rolled fragments, in the Buckle Burn (where it was originally discovered by Dr. Hector), Rees River, and Wakatipu Lake, as well as in small grains with arsenical pyrites at Waipori, is mentioned in the Jurors' Reports of New Zealand Exhibition, 1865, pp. 265, 414, and the specimen from Buckle Burn has again been described by Professor Liversidge (Trans. N.Z. Inst., vol. x., p. 503), but it was not till 1880 that the mineral was discovered *in sitû*, when Mr. McKay obtained it in a reef on the west side of the Richardson Mountains.

It is found as irregular masses in a quartz reef 4 feet in width, and carrying a considerable quantity of mispickel, which occurs at the junction of the chlorite schists and blue slate, but belongs principally to the chlorite schists.

Scheelite, or the Tungstate of Lime, has a very limited application in he arts. It is used for the production of tungstate of soda, a substance which has of late years supplanted stannates as a mordant, and also for fireproofing fabrics.

The various oxides of tungsten also afford excellent pigments, and Mr. Skey discovered as early as 1863 that in many cases it could be used as a substitute for tin, notably in the manufacture of Purple of Cassius. The black oxide of tungsten has been proposed as a substitute for blacklead. From its weight, this mineral is frequently found as an associate of gold in alluvial workings, and is known by the diggers as "White Maori."

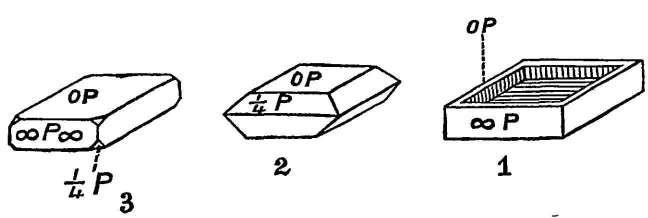
MOLYBDENUM.

Molybdenite, Mo''.—Specimens of this mineral occurring as flakes in a gneiss rock from Dusky Sound, were forwarded by Mr. W. Docherty for identification early in 1880, but very little of it has as yet been found.

It is used for the preparation of blue carmine for colouring porcelain.

Wulfenite, $\dot{Pb}\ \ddot{Mo}$.—A specimen of this mineral is in the Museum labelled as coming from the Dun Mountain, but I am unable to find any account of how it was received. It was called Mimetesite.

It occurs as crystals of a flat tabular form, belonging to the Tetragonal System, which are sometimes hollow.



consisting of (1) ∞P,OP; (2) ¼ P,OP; (3) ∞P∞, OP, ¼ P.

In colour it varies from wax-yellow to greyish-yellow; it has a hardness of about 3. Yields a metallic bead of lead on charcoal, decrepitates violently and colours a bead of phosphoric acid greenish blue. Its occurrence is interesting, this being the first mention of it in New Zealand.

CHROMIUM.

Chromite $(\dot{Fe}, \dot{Mg})\ (\dddot{Cr}, \dddot{Al}) = (RO, R_2O_3)$.—This mineral which consists essentially of a combination of ferrous oxide and chromic oxide with variable quantities of magnesic oxide, alumina and silica, is largely represented in New Zealand. It has chiefly been found in the District of Nelson, where at the Dun Mountain it was for sometime extensively worked, about 5,000 tons of the ore having been exported. It was first brought into notice by Mr. T. R. Hacket who also in 1861 opened a mine in Aniseed Valley in the same district (Jurors' Rep. N.Z. Ex., 1865, p. 18). It occurs in various forms throughout what is known as the mineral belt of Nelson, a band of serpentinous and olivine rocks, which has been traced through the country from D'Urville Island to Little Ben Nevis, and also occurs as an isolated block in the Red Hills.

The ore is found :—

1. *Massive crystalline.*—In bands of a black crystalline character, varying in its degrees of coarseness, and in some cases showing distinct planes of the octahedron when fractured. No perfect crystals have as yet been found. As a rule the crystalline bands have hitherto proved less continuous in their character than those next to be described.

2. *Massive amorphous.*—In bands of a brownish-black colour, and affording a brown streak. It is softer than the last-mentioned variety, and as a rule occurs in larger and better-defined bands of ore, which also appear to be more continuous both in length and depth. It is not so valuable an ore as the massive crystalline variety, but, on account of its greater extension, would probably receive a greater share of attention should works be undertaken for its extraction.

3. *Crystalline disseminated.*—A very interesting example of this ore occurs on Little Ben Nevis, consisting of small segregations of chromite evenly distributed through a pale-green serpentinous rock. The segregations are from ⅛ inch to ½ inch diameter, and are spotted through the rock with great regularity, giving it the appearance of a conglomerate. When found under these conditions the chromite corresponds in physical characters with the massive crystalline variety previously described, and the ore-bearing rocks appear to run in belts much the same as the regular ore bands do, and follow approximately the same course. The surrounding rock being soft, a mechanical means of separation for the ore so as to increase the percentage of chromic acid should be simple.

4. *Granular disseminated.*—In this character Chromite occurs as a constituent of the rock Dunite, described by Professor Hochstetter ("New Zealand," 1863, p. 474, Eng. Ed.), as follows :—"It consists of a very peculiar kind of rock, of a yellowish-green colour when recently broken but turning a rusty-brown on the surface when decomposing. The mass of the rock is Olivine, containing fine black grains of chromate of iron interspersed; it is distinguished from serpentine, for which it was formerly taken, especially by its great hardness and its crystalline structure. I have called it Dunite." These rocks occur in bands, which almost resemble dykes, and which are, perhaps, better developed in the Dun Mountain than elsewhere The quantity of Chromite which occurs in the rock is extremely variable from a few dispersed grains to sufficient to form more than half of the mass; and specimens have yielded as much as 44·75 °/$_o$, $Cr_2 O_3$.

This ore occurs as a 10-foot band in the Dun Mountain Company's lease, and in the Roding River Company's ground a similar band is over 15 feet in width, and has been opened on vertically for 300 or 400 feet. The better parts of this rock will probably prove a valuable ore of chrome, and some of second class quality may possibly be sufficiently concentrated to render them of value.

Analyses of Chrome ores from the Nelson district show that an average percentage of 50·62 Cr_2O_3 has been obtained from samples forwarded, and that half of these yield over 55 °/₀ Cr_2O_3, proving the Nelson Chrome ores to be of considerable value. These analyses varied as follows from the different localities:—

Starveall	44·21 per cent., Cr_2O_3.			
Little Ben Nevis	40·62 to 59·52	,,	,,	,,
Aniseed Valley	41·16 to 42·65	,,	,,	,,
Maungatapu	30·18 to 64·26	,,	,,	,,
Adams Lode	51·61 to 64·63	,,	,,	,,
Croixelles	43·44	,,	,,	,,
Wangamoa	52·17 to 64·80	,,	,,	,,
Dun Mountain	44·61 to 63·72	,,	,,	,,
Lake Harris Range, Otago	61·24	,,	,,	,,

Chromite has been found at Jackson's Bay, where it also occurs as a constituent of the rock Dunite. Specimens were first forwarded by Mr. D. Macfarlane, Government Agent there, in 1877.

It was also discovered by Dr. Hector, associated with Nephrite, in Milford Sound, and is mentioned in the Jurors' Reports N.Z. Ex., 1865, p. 265, as follows:—

"The large block of Nephrite, which weighs 200 lbs., and was brought by Dr. Hector from Martin's Bay, is speckled with this mineral (Chromite) in small grains. This interesting rock is therefore in all probability a local variety of the Dunite, which forms the matrix of the Chrome ore in Nelson."

Chromite of rich quality and granular structure has also been found at Milford Sound as a rolled fragment; it was associated with Steatite (Liversidge, "Trans. N.Z. Inst.," vol. x., p. 504) as well as another specimen from Moke Creek, Queenstown, and one brought by Mr. McKay from the Lake Harris Range, Otago, which yielded 61·24 °/₀ Cr_2O_3.

Uranium.

Uranium has not yet been found in New Zealand.

Manganese.

This metal occurs in nature chiefly in the form of various oxides, the main divisions of which are the hydrous and anhydrous ores.

Anhydrous Ores.

Pyrolusite, $\ddot{M}n$.—H. 2 to 2·5, colour iron-black to dark steel-grey, sometimes bluish; streak black; opaque; rather brittle. This mineral was discovered on the east coast of the Auckland district, in 1873, a specimen which contains some minute crystals being forwarded for identification by Mr. Ormond. A specimen was also forwarded by Mr. J. C. Stovin, in 1878, from the Auckland district, but these are the only two instances on record of this mineral having been found in New Zealand. It is the most valuable ore of manganese, on account of its containing a larger proportion of oxygen than any other class of manganese ore, and on that account generating more chlorine when treated with hydrochloric acid, in bleaching processes.

Hausmannite, $\dot{\mathrm{Mn}}.+\dddot{\overline{\mathrm{Mn}}}$.—H. 5·5. Colour brownish-black; streak chesnut brown; opaque. Fracture uneven.

This mineral is mentioned as occurring in rolled pieces in the river Selwyn, and coating joints in rocks. (See Dr. Haast's collection, Jurors' Reports N.Z. Ex. 1865, p. 258), but we have no sample in the Colonial Museum.

Braunite, $\dddot{\overline{\mathrm{Mn}}}$.—Streak and colour dark brownish-black; fracture uneven; brittle.

The first specimen of this mineral was forwarded by Mr. E. Toomath, from the Malvern Hills, Canterbury; it is a massive variety.

Another specimen was forwarded from the vicinity of Wellington, by Mr. W. S. Hamilton, in 1873, and in 1879 a specimen was sent from the Bay of Islands by Mr. J. C. Stovin. This last specimen was unfortunately lost at the Melbourne Exhibition.

Hydrous Ores.

Manganite, $\dddot{\overline{\mathrm{Mn}}}+\dot{\mathrm{H}}$.—H. 4. Colour dark steel-grey to iron-black, streak reddish-brown, sometimes nearly black; opaque. Fracture uneven. This class of ore is largely represented in New Zealand. It is mentioned as occurring in veins in schists, and as rolled fragments in the alluvial drift at Kawarau and Clutha (Jurors' Reports N.Z. Exhibition, 1865, p. 265) and in 1865 it was forwarded for identification from the Pioneer Claim, Dunstan, Otago.

Mr. Skey again mentions in 1871 the occurrence of this mineral at the Tararu Creek, Thames, where it is found in small columnar crystals, lining a cavity in an earthy-looking rock, and in the Yankee Doodle Claim at the same place it is found plentifully in a rich leader (Geological Reports, 1870–1, p. 86). It has also been found at the Bay of Islands and the Island of Waiheke, in Auckland Harbour, in both of which localities it has been worked for some time, as well as on the Island of Kawau for a little while, and at Whangarei, Tory Channel, Waipu, Waimarama and Wellington.

This mineral is inferior in its character as regards the quantity of available oxygen, but the small quantity of siliceous matter generally present enhances its value somewhat for iron manufacture, in which it is used for oxidising phosphorus, etc.

Psilomelane, $\dot{R}\ddot{M}n^2+\dot{H}$.—H. 5–6, massive and botryoidal; colour, iron-black passing to dark steel grey; streak brownish-black; shining, opaque.

This mineral is mentioned in the Jurors' Rep. N.Z. Ex., 1865, p. 258, as amongst Dr. Haast's collections. It was found in veins in the Upper Waimakariri.

It is also found at the Bay of Islands, where it occurs massive and forms the most valuable ore; at Kawau it is found both as a massive ore and also as botryoidal incrustations; and at Waiheke, Waipu, and Whangarei it also occurs, as well as at Ohariu, Wellington, associated with Manganite. It also occurs in large quantities in the island of Pakihi, Auckland, where it is found in numerous small veins, about 1 inch thick, running generally parallel to the cleavage of the slates, but sometimes at right-angles to it (Hutton, Trans. N.Z. Inst., vol. i., p. 168).

It is a valuable ore of manganese, consisting, as it does, of a mixture of MnO and MnO_2, but varies greatly in its composition, containing many impurities.

Analysis of Psilomelane from Bay of Islands.

Manganese oxides	75·46
Ferric oxide	11·76
Siliceous matter	2·74
Water	10·04
	100·00

Wad.—Composition various. $\dot{M}n. (\dot{C}a. \dot{B}a. \dot{K}.) \ddot{M}n.^2 + 3\dot{H}$.

This is a soft, earthy form of manganese, which varies greatly in its composition and general character, but includes all the softer hydrated manganese ores. It was first mentioned, in 1870, by Captain Hutton, as occurring in considerable quantities, associated with Calcite, in the Black Reef, at Tararu Creek, Thames (Geol. Rep. 1870–71, p. 5), and has also been found at Waiheke, Bay of Islands, Auckland, Napier, Whangarei, and Flaxbourne, and indeed occurs generally wherever other ores of manganese are found. It frequently forms an important ore of that metal, having a similar composition to Psilomelane, but containing a greater quantity of water, and varying more than that ore in the quantity of manganese which it contains.

Analyses of these ores show that they contain from 27·14 to 87·47 per cent. of oxide of manganese; from 12·05 to 28·1 per cent. of water, and from ·42 to 42·83 per cent. of silica.

The foregoing are the only ores of manganese which can be looked upon as of economic value, since their usefulness depends upon the amount of oxygen which they contain combined with the metal; and the black oxide,

MnO_2, which occurs pure in Pyrolusite, is the most valuable, on account of its parting readily with its oxygen to substances capable of combining with it, and on this property depends the value of the ore in the generation of chlorine for bleaching purposes, the decolourization of glass where sub-oxides of this metal form the colouring matter, and also in its recent application to the oxidation of phosphorus, etc., in the process of iron manufacture.

Manganese, however, also occurs in other forms, which require mention as minerals.

Diallogite, $\dot{M}n\ddot{C}$.—The occurrence of this mineral is mentioned by Mr. Skey (Geol. Rep. 1870–71, p. 85) associated with Calamine from a claim high up the Tararu Creek, Thames, and presented by the manager of Russell's battery.

He says: "The Diallogite of this specimen contains a portion of carbonate of lime, but the amount has not yet been ascertained. It is coloured with oxide of iron, and crystallized in large rhombohedrons. The carbonate of lime forms lustrous transparent crystals attached to the former, but always external. These are always well shaped, but comparatively small. They are interspersed somewhat rarely with small rock crystals." I regret that I have been unable to find this specimen.

A massive, flesh-coloured, specimen of this mineral was also collected by Dr. Hector, November, 1881, in Makara Valley, where it occurs on Mr. Thos. Robinson's property.

Rhodonite or Manganese Spar, $\dot{M}n\ \dddot{S}i$.—The occurrence of this mineral at Kawarau and Clutha is mentioned (Jurors' Rep. N.Z. Ex., 1865, p. 265), and at the Pioneer claim, Dunstan (Jurors' Rep., p. 413), and it has also been found in Canterbury and Waiheke.

Hauerite, Mn''.—In a paper read before this Society during the last session, I mentioned the occurrence of this mineral, as determined by Mr. Skey in rocks from the Wakatipu district, collected by Mr. McKay, and I have now to mention its occurrence in certain specimens forwarded by Mr. H. P. Washbourn from Collingwood, where it occurs in crystals composed of the cube and rhombic dodecahedron.

Dana only mentions this mineral as occurring at Kalinka in Hungary, in clay with gypsum and sulphur, in a region something like a solfatara, but the Mangan-blende or Alabandine which is a subsulphide of manganese, he states, occurs in veins in the gold mines of Nagyag in Transylvania, associated with Tellurium, carbonate of manganese and quartz. It is interesting, therefore, to note the occurrence of Hauerite in crystalline schistose rocks, and I was led by this to examine ores from other countries to see whether it ever did occur under similar conditions. The result of this examination has been to show that in the Bismuth ore from the granite district of Beaver County, Utah, this mineral is largely represented, and moreover, in a rock which very closely resembles the one from Collingwood.

Mr. Skey has tested this rock for Bismuth, but has not been able to detect the presence of this valuable metal; as, however, only two small specimens were forwarded, and these were taken from the outcrop, it by no means proves that a similar association may not occur here, and a careful examination of the rock in question may lead to valuable results.

Metallic Minerals.—Class II.

Metals brittle, easily fusible and volatile.

Arsenic.

This metal has only been found in New Zealand in a native state, in the form of arsenical pyrites, and in one instance as Dufrenoysite, a description of which will appear under the lead ores.

Native Arsenic.—The first mention of this mineral in New Zealand is by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 368), where he states that it occurs at the Kapanga Mine, Driving Creek, Coromandel, associated with gold; and subsequently Captain Hutton, in his report on the geology of Coromandel (Geological Reports, 1870-1, p. 5) again mentions its occurrence in the same locality.

The specimens which I have seen are all reniform and massive, and have all been obtained from the Kapanga goldmine; they are all tarnished to a blackish-grey colour, and are sometimes deposited on calc spar. In some cases free gold can be seen on the surface of the arsenic.

Dr. Hector informs me that he had the good fortune to see a specimen extracted from the No. 5 Driving Creek Mine, which showed in a very characteristic way the manner of occurrence of this metal.

The specimen consisted of a geode or cavity, formed at the point of intersection of two slender quartz veins, which was lined partly up its sides by a coating of quartz. On this a mass of Calcite was crystallized, while both on and through the mass of these Calcite crystals arsenic had been deposited in a botryoidal form. On the surface of this was a deposit of Chalcedony, from which long slender quartz crystals had grown, and by a subsequent action the terminal facets of these had been coated by small globular patches of arsenic, as if sublimed, sprouting from which were beautiful crystalline filaments of gold.

Although, as is much to be regretted, this specimen was not secured for the Colonial Museum, having been presented to H.E. Sir George Bowen, still, specimens collected by Dr. Hector from the same druse are yet in the possession of the Geological Survey, and these demonstrate the interesting points of the description already given.

One of these specimens shows the tufanite (pyritous propylite) forming one side of the vugh or cavity, on which a layer about $\frac{3}{8}$-inch thick of fibrous crystalline quartz has been formed. At the base of the specimen a quartz leader about 3 inches wide and crystallized in small vughs near the centre is inserted through the lining of the cavity, which is formed by the junction of two small veins. This leader is traversed by small strings of crystals of Mispickel or Leucopyrite, and on the internal quartz coating of the cavity Calcite has crystallized at places in large rhombohedral forms, and at others the arsenic has been deposited in reniform masses.

On the faces of the Calcite crystals small globular patches of arsenic have formed, and stalagmitic incrustations of Calcite, with alternate layers of arsenic, have been built up on these, forming fine reniform masses. At one point, near the top of the specimen, minute quartz crystals can be seen, also Calcite forming hollow pseudomorphs of quartz, all the cavities of which are filled with the most beautiful filaments of gold; a few crystals of Mispickel are here visible.

The other specimen is of a massive reniform character, and is deposited on the quartz lining of the vugh without the interposition of Calcite as in the first specimen.

Mispickel, $Fe''+FeAs$, or arsenical iron pyrites, is by no means uncommon in New Zealand. It is mentioned by Dr. Hector, (Jurors' Rep. N.Z. Ex., pp. 265, 436), as occurring in magnesian felstone and diorite in Milford Sound, and also in alluvial drifts at Waipori and elsewhere, and is again referred to by Professor Liversidge, in his description of the minerals of the Otago Museum (Trans. N.Z. Inst. vol. x., p. 502). At page 257 of the Jurors' Reports, above cited, this mineral is mentioned in Dr. Haast's collection as occurring in diorite at the Malvern Hills.

Specimens have been collected by Mr. McKay from the Buckleburn, on Wakatipu Lake, as fine crystals imbedded in chlorite schists, and, as previously mentioned, it occurs in the auriferous leaders of the Kapanga mine, and is found in most other auriferous reefs. Specimens brought by Dr. Hector from Langdon's lower reef, near Greymouth, proved to be highly auriferous, the assay of the sample showing 69 ozs. 3 dwts. 12 grs. of gold, and 2 ozs. 9 dwts. 19 grs. silver, to the ton, a considerable proportion of it, however, being in a free state.

I collected specimens of the same mineral from the Perseverance mine, Collingwood, where it occurs in very characteristic rhombic crystals, in a white granular quartz, but contains very little gold.

As a rule this class of pyrites is the most highly auriferous, although at times gold also occurs largely in the more common form of iron pyrites.

ANTIMONY.

This metal has been found in New Zealand in the form of Stibnite, which mineral has a pretty wide distribution, and is associated with Kermes and Cervanite, as products of decomposition or change. It has also been found as Bournonite (a mineral which more properly belongs to the lead ores), in the Rolling River, Wangapeka, and again as a constituent of Richmondite, a form of Tetrahedrite, which occurs at the Richmond Hill Mine, Collingwood.

Stibnite, $\not{\mathrm{Sb}}'''$.—The first mention of the occurrence of this mineral in New Zealand is by Dr. Hector (Jurors' Rep. N.Z. Ex., p. 265). The specimen was from the Arrow River, and was exhibited in the Otago geological survey collection at the Dunedin Exhibition. In 1867, Captain Hutton in his report on Thames goldfield, p. 9, published in the Geological Reports for that year, mentions the occurrence of crystals of Stibnite more than an inch long imbedded in tufa in one of the claims up the Waiotahi Creek, and Professor Liversidge (Trans. N.Z. Inst. vol. x., p. 502) describes a specimen of the same mineral from the Union Jack Reef, Mullocky Gully. Besides these, specimens of Stibnite have been forwarded to the Museum from time to time from Coromandel; Kaueranga; Napier; Queen Charlotte Sound; Criterion Claim, Thames; Tararu Creek; Greymouth; Pakaraka, Bay of Islands; Green Island, Otago; Shield's Reef, Reefton; Kelly's Reef; Canoe Creek; Collingwood; Inangahua; Westport; Pelorus Sound; Marlborough; Hokitika; Paparoa Range, Greymouth; Langdon's Reef, Greymouth; Dunedin; and Featherston; some by officers of the Geological Survey, and others by contributors whose names will be found in the Colonial Museum and Laboratory Reports. In describing the modes of occurrence of Stibnite, a natural subdivision presents itself between the crystalline and massive varieties.

Crystallized varieties.—We have specimens in the Colonial Museum of some fine interlacing crystals of Stibnite from Tararu Creek, where they occur as an accessory mineral in the auriferous reefs. Some specimens of these are very fine and are associated with crystallized quartz. From Kaueranga (Shortland), there is a very fine specimen of crystallized Stibnite, in which the crystals interlace in a most characteristic manner. From the Golden Crown Claim, Thames, there is a group of crystals of large size, the longest one measuring about 4 inches along its principal axis. The only forms of crystals which are represented from any of these localities are prismatic, consisting of the rhombic prism ∞P. and the brachy-pinacoid, $\infty\breve{P}\infty$; with pyramidal ends composed of the pyramid P. and several brachy-pyramids, mPn, which give the ends a rounded appearance and are not sufficiently defined for measurement. All these crystals are deeply striated vertically.

Massive varieties.—The massive varieties are more widely distributed and assume a greater economic importance since they are found as the principal constituents of lodes in various parts of the colony. Perhaps the most important of these is the ore from Stoney Creek, Waipori. It consists of a massive crystalline variety of Stibnite occurring in a lode 2½ feet thick, which has been traced for a distance of 200 feet, and is reported to be met with as outcrops for a much greater distance. The pure ore is mixed with about 30 per cent. of gangue in the lode (Rowe, Geol. Rep. 1879-80, p. 155).

A massive sub-crystalline variety from Endeavour Inlet, Queen Charlotte Sound, consists of a mixture of nearly pure Stibnite with quartz; and a series of analyses have given 69·4 per cent.; 36·36 per cent; 58·25 per cent.; 51·12 per cent; 44·28 per cent.; 19·01 per cent.; and 17·20 per cent. of Antimony, and they contain from 3 to 8 dwts. of gold per ton.

This ore was found scattered as large blocks through a surface deposit, and a reef was also found which carried Stibnite on its back, but passed afterwards into a poor auriferous quartz, and it is probable that the real source of the ore has not yet been found.

A very interesting occurrence of auriferous Stibnite has been discovered at Langdon's, near Greymouth. The first specimen of this ore was forwarded from Hokitika by Mr. McRae, and yielded 84 ozs. 9 dwts. 19 grs. of gold and 36 ozs. 4 dwts. 5 grs. of silver per ton. The large quantity of gold found in this specimen gave an air of probability to the supposition that telluride of gold was present; but when an examination for Tellurium was made none was found, and a large proportion of free gold was shown to exist.

Dr. Hector subsequently examined this reef, and in the Geological Reports, 1878-79, p. 19, he says:—"Following up the same creek, at an altitude of 400 feet above Langdon's reef, the lode from which the auriferous Stibnite is derived has been discovered, having a thickness of 9 feet, and dipping at 60° to the south-west. It is cased in a hard, blue, cherty slate, and has a banded structure, consisting of five distinct bands—

	Ft.	in.
No. 1, next the foot-wall, is quartz containing Stibnite, dispersed in irregular masses	2	0
No. 2, *compact Stibnite*	2	0
No. 3, Stibnite, including quartz in the form of nodules	3	0
No. 4, fine-grained mixture of quartz and Stibnite	0	4
No. 5, breccia of slate	1	8
	9	0"

The following returns were obtained by assay of these samples:—

No. 1.—*Quartz and Stibnite.*

a contains 2 ozs. 10 dwts. 7 grs. gold per ton.
b ,, 2 ,, 0 ,, 6 ,, ,, ,,

No. 2.—*Compact Stibnite.*

a	contains	5 ozs.	16 dwts.	16 grs.	gold	per ton.
	,,	0 ,,	4 ,,	1 ,,	silver	,,
b	,,	0 ,,	15 ,,	2 ,,	gold	,,
c	,,	32 ,,	0 ,,	17 ,,	,,	,,
	,,	1 ,,	3 ,,	3 ,,	silver	,,

No. 3.—*Stibnite and Quartz in Nodules.*

a contains no gold.
b ,, 10 dwts. 2 grs. gold per ton.
c ,, no gold.

No. 4.—*Fine-grained mixture of Quartz and Stibnite.*

a contains	4 ozs.	12 dwts.	13 grs.	gold	per ton.
,,	0 ,,	3 ,,	0 ,,	silver	,,

No. 5.—*Breccia.*

Contains no gold.

In No. 2 *(c)*, the gold was visible in the stone, running as a thin vein through the centre of the specimen, and, a large proportion being free, it can readily be separated by washing.

Kermes (Antimony Blende), $\mathrm{Sb}'''_2\ \dddot{\mathrm{Sb}}$.—This mineral occurs generally with the Stibnites, as a cherry-red encrusting earth on exposed parts of the specimen.

Cervantite, $\dddot{\mathrm{Sb}}$, $\overset{\therefore}{\dddot{\mathrm{Sb}}}$.—Occurs incrusting Stibnites at most localities.

Tellurium and Bismuth.

The other members of this group have never yet been discovered in New Zealand, with the exception of traces of the latter metal in the Richmondite of Collingwood, but the striking resemblance of some of the rocks of that district, and the occurrence of associated minerals which are common with the Bismuth ores of Beaver County Utah, make it by no means improbable that we shall yet have to add that valuable metal to the list of those which occur in New Zealand.

Metallic Minerals.—Class III.

Malleable, not reducible by heat alone.

Zinc.

This metal is met with in New Zealand, chiefly as the sulphide or Zinc Blende, but in one instance the mineral Calamine, or carbonate of zinc, has been obtained.

Zinc Blende, Zn'.—The first mention of the occurrence of this mineral in New Zealand is by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 368) where he refers to its occurrence on the Thames goldfield, associated with gold in some of the reefs, and it was originally discovered by Captain Hutton in a claim situated upon the Tararu Creek, in the Thames district, where it occurs in moderate sized dark-coloured crystals, having a pyramidal (tetrahedral) form, and is associated with iron pyrites, acicular crystals of quartz, Galena, and traces of copper. Its matrix is a pure amorphous quartz. Specimens of blende were subsequently forwarded by the same contributor from Mine Bay, Great Barrier Island.

In the same year Mr. Davis (Geol. Reports, 1870-71, p. 61), mentions its occurrence at the Silver Crown Claim, Thames; at page 85, Mr. Skey mentions its occurrence at the Thames, and at page 149, Captain Hutton also notes its presenee in the New Golden Crown Claim, in the same district. He also (at page 154) mentions the occurrence of this mineral in the Perseverance mine, Collingwood.

Besides these localities Zinc Blende has since been found in the reefs at Mount Arthur, whence the gold is extracted.

All the specimens of Zinc Blende which have come under my notice are of a massive character but vary somewhat in appearance. The specimens from the Thames goldfield, which are well represented by those obtained from the Little Agnes mine, Tararu Creek, are black resinous samples of the mineral, known as "Black Jack." That from Collingwood varies from Black Jack to a yellow honey-coloured Blende, containing from 59°/₀ to 65°/₀ zinc, and Captain Hutton thus describes its mode of occurrence:—"At about five feet above the lode, in the felspathic slate, is a band some five or six feet thick, of Zinc Blende and Galena. In the lower part of this band, the Blende is bluish-black, with a metallic lustre, while towards the upper part it is associated with Galena, which is sometimes crystallized, and here it is of a pale yellow colour, and a resinous lustre." (Geol. Rep., 1870-71, p. 150.)

In examining this locality last year, I was led to the conclusion that at one part of the mine at least this Zinc Blende and Galena formed a part of the lode since it occurred associated with quartz and Mispickel, had the grey felspathic slates for its hanging wall and black slates at the foot, which corresponds to the general position of the main Perseverance reef. Subsequently, however, I am informed a small shaft was sunk and the main reef discovered 6 feet below this Zinc Blende and Galena vein, as described by Captain Hutton, so that possibly these deposits are offshoots from the main reef. The other localities where Zinc Blende has been found do not merit special description, as in no other case has it been discovered in sufficient quantities to prove of commercial value.

Calamine, $\dot{Z}n\ \ddot{C}$.—Mr. Skey (Geol. Rep. 1870-71, p. 85) describes this mineral from Tararu Creek, Thames, as "lustrous transparent crystals attached to Diallogite, but always external; these are well shaped but comparatively small; they are interspersed somewhat rarely with small rock crystals." This is the only instance yet recorded of the occurrence of Calamine in New Zealand. Zinc also enters into the composition of Richmondite previously referred to.

Lead.

The ores of lead which have hitherto been discovered in New Zealand are native lead, Galena, Dufrenoysite, Mimetesite, and Bournonite, as well as a doubtful case of Pyromorphite, and red oxide of lead.

Native Lead.—In the Geol. Reports, 1870-71, p. 85, Mr. Skey mentions the occurrence of native lead in the wash of a creek at the Thames. It occurs in the form of shot, but was found at the very commencement of the goldfield, so may possibly lay claim to being the native metal.

Galena, Pb′.—This mineral is widely distributed in the colony, but has not hitherto been worked. The first mention of its occurrence is by Mr. J. C. Crawford in his "Essay on the Geology of the Wellington Province," p. 5, where he mentions that specimens were brought by Professor Hochstetter's party from the Kaimanawa Ranges. In the Jurors' Rep. N.Z. Ex., pp. 404, 265, and 437, mention is made of the occurrence of Galena in the Nelson District, and also pretty generally throughout the colony, but in most instances associated with a great deal of quartz. Captain Hutton has mentioned its occurrence at Great Barrier Island; Perseverance Mine, Collingwood; and also at the Thames—this last district being again referred to by Mr. Skey and Mr. Davis. Dr. Hector refers to the silver lead ore of the Wangapeka, and I have mentioned its occurrence as thin veins in a large quartz reef at Richmond Hill, Collingwood; in boulders in the rivers on the West Coast, south of Mount Cook; and associated with pyrites at the Mount Rangitoto Mine. These comprise the principal localities at which Galena has been discovered, but the only one in which the ore has been yet found in sufficient quantities to promise well for opening a lead mine is at Bedstead Gully, Collingwood, where some rather important deposits were discovered in the workings of the Perseverance Gold Mining Company, but even these have received but little attention. Galena occurs in all degrees of coarseness from a very fine grained ore to a coarsely crystallized variety, and the samples which have been assayed for silver show a great variation in the proportions of this precious metal contained by them, but a notice of these will more properly be placed under the silver ores. The crystals observed have been uniformly cubes, the octahedron never being seen.

Dufrenoysite, Pb′ + ½ $As^2 S^3$.—Great Barrier Island. The composition of the type mineral as given by Dana is

Sulphur	22·1
Arsenic	20·7
Lead..	57·2
	100·0

But, in addition to this, the mineral from the Great Barrier contains a little antimony and traces of copper, silver, and iron. It occurs as a finely crystalline vein associated with Galena in larger crystals, the matrix being diorite, and was collected by Captain Hutton from Mine Bay, Great Barrier Island.

Mimetesite.—The specimen representing this mineral, which is included in the Melbourne Exhibition Catalogue as coming from the Dun Mountain, has proved on further examination to be Wulfenite, or molybdate of lead, and is accordingly described under Molybdenum.

Bournonite, $\text{Pb}'^{4}\,\bar{\text{Sb}}''' + \bar{\text{Cu}}'^{2}\,\bar{\text{Sb}}'''$.—A specimen of this mineral was collected from the Rolling River, Wangapeka, Nelson, in 1867. No further specimens have been obtained. It occurs in quartz with Galena, is of a steel-grey colour, and has a metallic lustre.

It consists of sulphide of antimony and lead, with a little sulphide of copper and traces of iron and silver as sulphides.

Tin.

Cassiterite, $\ddot{\text{Sn}}$.—It is from one locality only in New Zealand that any well authenticated discovery of tin ore has been made, and the specimens in question were obtained from tailings of certain auriferous cements at Lankey's Gully, Reefton, being forwarded for identification by Mr. A. D. Bayfield, of Nelson.

The Cassiterite occurs as small grains, associated with iron pyrites and an iron-black hematite (Black Maori of the diggers), and although up to the present time the extent and value of the deposit have not been determined, the discovery is at least of interest, and may lead to one of considerable importance.

It should be mentioned that during the year 1876 specimens purporting to have come from Tuapeka, and containing tin, were forwarded to the Museum through Mr. Blair, but this discovery has not been further confirmed.

Cobalt.

Hitherto the presence of Cobalt in New Zealand has only been proved in very small quantities, and the localities at which it has been obtained are also comparatively few.

Cobalt Bloom—Erythrine, $\dot{\text{Co}}^{3}\,\dddot{\bar{\text{As}}} + 8\dot{\text{H}}$—This mineral is mentioned by Dr. Hector (Jurors' Rep. N.Z. Ex., 1865, pp. 265, 437) as occurring in the schists and gneiss of the West Coast of Otago.

Asbolite.—This mineral, which is an earthy wad in which Cobalt frequently occurs, is mentioned by Mr. J. A. Pond (Trans. N.Z. Inst., vol. x., p. 456) as occurring in four distinct places in the Auckland district, but the localities are not cited. The highest return which he obtained was 2·42 per cent. Cobalt.

Mr. Skey has also examined many of our wads for Cobalt, but has only recognized that metal in a bog ore from Rapaka, Bay of Islands, where, however, it only occurred in minute quantities (13th Mus. and Lab. Rept., p. 27), and I also found traces of the mineral in some of the Kawau manganese orés (14th Lab. Rept., p. 33). Hitherto ores of this metal have not been found in New Zealand in payable quantities.

NICKEL.

This metal while being somewhat widely distributed in New Zealand, has not hitherto been found under circumstances which would render its extraction remunerative.

Pimelite, $2\,\ddot{\text{Al}}\,\ddot{\text{Si}} + 3\,\dot{\text{Mg}}\,\ddot{\text{Si}} + 10\,\dot{\text{H}}$, in which 3 per cent. of nickel oxide is known to occur, was first discovered in New Zealand by Dr. Haast, filling cavities in the amygdaloidal rocks of the Malvern and Clent Hills, and is mentioned in the Jurors' Rep. N.Z. Ex., 1865, p. 257. I cannot find any analysis of these specimens, so am unable to quote the percentage of Nickel present in them.

Troilite or Pyrrhotine (magnetic pyrites), Fe′.—This mineral, which is an inferior sulphide of iron, usually contains as a constituent portion of it both copper and nickel, and it is from the nickeliferous varieties of this mineral that the larger proportion of our commercial nickel is derived. I first discovered this mineral in January, 1876, in the river-beds south of Mount Cook on the West Coast of the South Island, and several specimens which I brought from localities some distance apart were found by Mr. Skey to contain Nickel although not in payable quantities. Specimens were subsequently forwarded from the Paringa River in the same district by Messrs. Thos. Ward and Co.

Pyrrhotine was again noticed in a series of specimens forwarded by Mr. W. Docherty, from Dusky Sound, in 1877, where it occurs in association with copper pyrites. Several of these specimens were tested for Nickel, in all of which it was shown to occur, but only in small quantities, the largest yield of this metal obtained being ·68 per cent., a return far too low to allow of remunerative extraction.

During the same year Mr. H. Washbourn forwarded a specimen of Pyrrhotine from Collingwood, where it occurs in a reef on the mineral lease of the Richmond Hill Silver Mining Company, and when examined for Nickel it yielded 2·98 per cent. of this metal, and traces of Cobalt. As Nickel is extracted from this ore in New Jersey, U.S., when only 3 per cent. is present, this should prove payable if the lode is continuous and sufficiently large.

Silicate of Nickel.—In the Trans. N.Z. Inst., vol. x., p. 454, Mr. J. A. Pond mentions the occurrence of Nickel in several specimens from different localities in the Auckland district, which are as follow;

1. Loose stones at Mahurangi, which are composed of silicate of magnesia, and in which Nickel occurs in small and variable amounts.

2. Portions of a large rock mass of serpentine, which is found cropping out in the direction of Hoteo, from Mahurangi, were found to contain ·49 per cent. Nickel.

3. Serpentine from small streams near Manukau North Head, contained ·47 per cent. Nickel.

4. Calcite from Matakohe, stained with hydrated silicate of Nickel.

5. Hard greenstone from Papakura Valley, gave a trace of Copper and ·26 per cent. Nickel.

6. Green unctuous clay from Waipu, gave ·11 per cent. Nickel.

7. Foliated serpentine from Coromandel, also gave a trace of Nickel.

During the past year I visited the locality from which No. 2 of Mr. Pond's specimens was obtained and collected specimens of a green siliceous rock which occurs in considerable mass on the Port Albert Road from Mahurangi. This rock Mr. Skey reports contains the oxide of nickel at the rate of 1·81 per cent., and appears to be in the form of a silicate. As it occurs as an isolated outcrop, it is impossible to say what its relations are, but seeing that it is free from sulphur and would thus obviate the necessity of roasting before treating in the ordinary way, a small percentage would no doubt pay for extraction, and it appears probable that richer deposits will yet be found in the district.

Iron.

This metal is largely represented in New Zealand, where it occurs in most of the known and more valuable forms both as oxides, sulphides, carbonates, and silicates, besides some interesting samples of phosphate and sulphate and the titaniferous iron ores.

Magnetite, $\dot{Fe}\ \dddot{\overline{Fe}}$.—This mineral, which consists of a mixture of the ferrous and ferric oxides, does not occur in a massive form in New Zealand, so far as is at present known, but is disseminated through various rocks in minute octahedral crystals and grains. It is principally developed in the chlorite schists on the western side of the main range in the South Island, where in the neighbourhood of Mount Cook, large quantities are found disseminated through the bed rock in the form of minute crystals, which at places become so plentiful as to form beds, interstratified with the schists, from 6 inches to 8 inches in thickness. Similar deposits are found at Lake Harris, in the Wakatipu district, where the Magnetite occurs in small veins and octahedral crystals dispersed through the rock, associated with thin bands of Hematite and crystals of specular iron. It is also largely represented in the volcanic rocks of New Zealand, associated in many cases with titaniferous iron, and from these rocks the greater quantity of our magnetic iron sand has been derived.

Hematite—Specular Iron, $\dddot{\mathrm{Fe}}$.—This mineral, which is the peroxide of iron, occurs associated with the same rocks (chlorite schists) as deposits of anhydrous hematite, which are of considerable value. This ore occurs as lenticular masses, which form a central band, extending from the upper part of Moke Creek, near the Wakatipu Lake, through Benmore and thence in the direction of Mount Gilbert. They are not, however, confined to this line, but occur throughout this schistose formation in the Wakitipu district, and appear to have their greatest development between Skippers and Moonlight Creeks. A six feet vein in mica schist occurs at Maori Point on the Shotover.

This mineral also occurs as small single crystals (generally rhombohedral) dispersed through a hard quartzose schist in the same district.

It is from the above deposits that the large boulders and minute grains of iron-black hematite are derived which are so generally associated with the auriferous deposits of our southern goldfields, and which are called by the diggers "Black Maori," by whom they are looked upon as an indication of gold, in consequence of their high specific gravity.

Analyses of several specimens of anhydrous hematite from Dunstan, Otago; Maramarua, Auckland; Otamataura Creek, Collingwood; and Wangaroa, Auckland, have been made at the Colonial Laboratory, and show that they contain from 61 per cent. to 68 per cent. of iron. The detailed results will be found in the Colonial Museum and Laboratory reports, or in the Manual of the Mineral Resources of New Zealand, in course of publication.

Limonite—Hydrous Hematite, $2\,\dddot{\mathrm{Fe}}+3\,\dot{\mathrm{H}}$.—This mineral occurs throughout New Zealand, not, however, in most cases in sufficient quantities to be of any value. At two localities, both near Collingwood, large and valuable deposits are found under very different conditions. The best known of these deposits is that situated on the south-east side of the Parapara River, and about a mile from its mouth. The ore occurs in massive, earthy, botryoidal, mammillary, and concretionary forms. Its colour is various shades of brown, commonly dark and none bright; when earthy it is a brownish-yellow or ochre-yellow. When concretionary in character the ore forms hollow spherical masses commonly known as pot or bombshell ore. It occurs as a vein associated with crystalline metamorphic limestones which occupy a considerable area of country, and in the vicinity of the mouth of the Parapara River the degradation of the rocks has covered a large area with this hematite in boulders, some of enormous size. It also forms the matrix of a quartz conglomerate there. On breaking some of the masses of ore a kernel of undecomposed pyrites is frequently found, and crystals of iron pyrites of large size are very common in some places. From this, and the fact that its mode of occurrence and mineral character favour the conclusion, I am inclined to think that this deposit of brown hematite is nothing more than the gossan of some very large pyritous lode. It has been estimated that 52,893,058 tons of the ore are exposed at the surface.

The other important deposit of brown hematite was discovered by Mr. McKay in 1878, at Mount Peel in the Nelson district, and contains 54 per cent. of metallic iron. The ore, which is a dark-brown compact one, is associated with fine-grained breccias, dark slates weathering white, and heavy beds of compact blue crystalline limestone which overlie the great series of breccia beds and conglomerates which form the western part of the Mount Arthur range. Where the specimens were obtained the bed was about 50 feet thick, and isolated masses 10 feet to 15 feet across were also observed; while to the north of the Takaka a much greater development takes place, and diggers report the ore in this locality to be about a mile in width.

Besides these important deposits many specimens have been received at the Museum for identification or analysis, from the following localities:—Pitt's Island; Thames; West Coast; Makara, Wellington; Kawau; the Bluff; Raglan; Riwaka, Nelson; Big Muddy Creek, Manukau; Wharekawau; Wangaroa North; Manawatu Gorge; Paringa River; and Tawa Flat; and these have yielded from 29 per cent. to 60 per cent. metallic iron. The details of these analyses are included in the Colonial Laboratoy Reports and the Manual of the Mineral Resources before-mentioned.

Chloropal, $\ddot{\text{Fe}}\,\dot{\text{Si}}^2$.—Professor Liversidge (Trans. N.Z. Inst., vol. x., p. 497) mentions the occurrence of this mineral in New Zealand, presented to the Otago Museum by Captain Fraser. The following is his description of the specimen:—"Of a yellowish-green colour; somewhat foliated cone-in-cone structure; sectile, soft; easily polished, even by rubbing with the thumb; adheres slightly to the tongue: when immersed in water gives off air-bubbles, and becomes translucent. Before the blowpipe does not decrepitate; blackens immediately, and fuses with difficulty on the edges, with slight intumescence, to a black glassy slag."

Siliceous Hematites.—Besides the foregoing ones, there are a few instances of hematites occurring in which the percentage of silica is so high as to make it advisable to class them under a different head. These ores are generally of a rusty-brown colour, of varying degrees of hardness, and seldom contain more than 20 per cent. metallic iron, and in some cases a good deal less.

Specimens have been received from the Dun Mountain, Nelson; Paringa River, Westland; and the neighbourhood of Wellington.

Bog Iron Ore is another form of hydrous hematite which is found at several localities in New Zealand. It is, generally speaking, of a porous character, and varies considerably in its composition. It has never yet been found in any considerable mass, and is seldom of much value on account of the phosphorus which most samples contain.

Analyses have been made of samples from Spring Swamp, Whangarei; Wainui-o-mata, Wellington; Carterton; Rangitikei; Stoke, Nelson; and Oroua Downs; in which the percentage of metallic iron varies from 19 to 51.

Spathic Iron Ores, Ḟe C̈.—The massive forms of these ores, which are essentially carbonate of iron, are very widely distributed in New Zealand, being, as a rule, associated with the cretaceo-tertiary and coal formations. Bands of clay ironstone, about 2 feet thick, occur in the Waipara District, and another band of sandy clay iron ore, 10 feet thick, is mentioned by Dr. Haast in the same locality (Geol. Rep., 1870-71, p. 11). Ironstone boulders are found in the Kakanui River which have been derived from the concretionary greensands. Valuable deposits of clay-band ironstone occur near Mount Somers and in the Malvern Hills, associated with coal, and further deposits are also found near the Abbey Rocks, Westland. Associated with the coal measures on the Twelve-mile Beach north of the Grey River, and thence inland, valuable deposits of spathic iron ore occur as lenticular masses and concretions in the shales. They are also notably developed in the Nine-mile Creek in the same district. They are again found at Jenkins Hill, Nelson, and at the Collingwood Coal-mine, where a bed of black-band ironstone also occurs, and another instance of its occurrence is at the Baton River, Nelson, in the cretaceo-tertiary formation.

In the North Island, beds of spathic iron ore have been found in the same formation, at the Miranda Colliery, inland of Taranaki, at the Manawatu Gorge, at Wangaroa and Raglan. In most of these localities the ironstones are fossiliferous, and contain numerous and well-preserved impressions of dicotyledonous leaves.

Further deposits of spathic iron ore also occur in the Mataura series, having been discovered by Mr. McKay, in the Cairn Ranges, Malvern Hills. They occur as strings and lenticular patches, with beautifully-preserved fossil ferns, and are of considerable importance.

Analyses of ores of this description have shown that they contain from 8·53 per cent. to 46·06 per cent. metallic iron, and the details of these will be found in the works above cited. They are all brown, sandy-looking ores, and are specially valuable on account of the ease with which they are reduced.

Siderite, Ḟe C̈.—The occurrence of this mineral in cavities of the contorted schist of Otago is mentioned by Dr. Hector (Jurors' Rep. N.Z. Ex., 1865, pp. 264–436), but we have no specimen in the Museum. Professor Liversidge again mentions the occurrence of this mineral at Dunedin (Trans. N.Z. Inst., vol. x., p. 494), as well as a magnesian ironstone from the Clutha.

Sphærosiderite occurs as an accessory mineral in many of our volcanic and dyke rocks. Thus Dr. Hector mentions it as occurring in basalt (Jurors' Rep. N.Z. Ex., pp. 264 and 436), and Dr. Haast mentions its occurrence in dyke rocks, and in the volcanic rocks of Banks Peninsula and the melaphyres of Mount Somers (Jurors' Rep., p. 258; Geol. Rep., 1873-74, p. 4, and Trans. N.Z. Inst., vol. xi., p. 504). It is generally found as small rhombohedral crystals, lining cavities in these rocks.

Dendritic Iron markings are of very frequent occurrence in all the harder and jointed rocks, some of them being of exceeding beauty. They are frequently mistaken for fossil ferns, which they very much resemble at times.

Ilmenite (Titanate of Iron).—This species includes several varieties due to the isomorphous characters of titanic and ferric oxides, so that the percentage of titanic acid present varies very considerably in different specimens. It is of very common occurrence as an accessory mineral in the volcanic rocks, where it occurs as small rhombohedral crystals, affording generally triangular or pentagonal sections when cut, and it enters largely into the composition of many of the ironsands of New Zealand, which surround so large a proportion of our coast. These ironsands are composed of a proportion of titanic iron, ranging from 2·4 per cent. to 74·2 per cent. of the whole, mixed with Magnetite and Hematite in varying proportions.

It is very difficult to group these in any definite order by the amount of titanic acid present, but it is noticeable that amongst those which occur on the southern beaches and also in the river beds the percentage is frequently high, ranging from 40 to 74 per cent. of titanic iron, and these have been principally derived from the basaltic rocks of the district.

On the other hand, the ironsands of the west coast of the South Island are practically free from TiO_2 in many cases, while the well known Taranaki ironsand only contains from 6 to 8 per cent. of titanic iron. There are, however, many ironsand deposits in Otago and Southland which contain from 2 to 8 per cent. titanic iron only, so that it is impossible to assign special areas over which any percentage will hold. Such, however, is not the case if we seek the rocks from which these ironsands have been derived, for we there find that the basaltic rocks have as a rule yielded an ironsand in which the percentage of titanic iron is over 50; that the granitic rocks seldom yield a sand in which the percentage of titanic iron is over 8; and that the trachytic rocks, like those of Taranaki, and which may be looked upon as mineralogically allied to the granites and syenites on other grounds, also yield an ironsand having a small percentage of titanic iron.

Where ironsands occur which are intermediate between the two extremes it is due either to a mixture of those derived from two distinct sources, or else the percentage of titanic iron has been increased by the presence of diabase or diorite dykes.

Menaccanite.—Mr. Skey mentions the occurrence of this mineral (titaniferous iron ore) from Brancepeth, Wairarapa (8th Lab. Rep. p. 15). It occurs with felspar, by which it appears to have been cemented together.

Iron Ochre occurs as a deposit from chalybeate springs and ferruginous waters in many mines both of coal, gold, and copper.

Iron Pyrites, Fe''.—This mineral is exceedingly widely distributed in New Zealand, indeed may be considered as general in its distribution. At Parapara, Collingwood, very perfect octahedral crystals are of common occurrence over part of the limonite deposit previously mentioned, and cubical crystals are of frequent occurrence in the chlorite schists and lepidomelane schists of the metamorphic region of the West Coast and Wakatipu Lake district.

It is of frequent occurrence as isolated crystals dispersed through the auriferous rocks of the Thames (tufanites), and also in many of the slates, and again forms an important element in the composition of many of the auriferous quartz reefs both north and south.

It also occurs as important lodes in the Collingwood district, where several of these are known to occur, and all that have been tested are more or less auriferous in character. These pyrites lodes are found—

1st. In felspathic slates which are associated with the auriferous reefs, the largest yet known being about 4 feet wide.

2nd. In the crystalline limestone; a reef in the Parapara River, above McGregor's Creek, being at least 8 feet wide, and composed of a fine-grained compact pyrites. As I have previously pointed out it is also probable that the limonite deposits of the Parapara are also the back of a large pyritous lode.

At Mount Rangitoto, in Westland, a pyrites lode, with which is associated about 20 per cent. galena, occurs, and this is frequently highly auriferous, containing from 5 to 13 ozs. of gold per ton. It is associated with schists and granites. The late Mr. E. H. Davis has described (Trans. N.Z. Inst., vol. iii., p. 287) a new form of iron pyrites, probably a pseudomorph, from the Chatham Islands. He says: "The system is oblique, nearly isomorphous with felspar, but having the clino-diagonal longer; the faces, which are smooth and brilliant, are ∞P; OP; P; $nP\infty$ hemidome, and $nP\infty$ clinodome."

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Marcasite (*Radiate Iron Pyrites*), Fe″.—This mineral, which crystallizes in the rhombic system, is of very frequent occurrence associated with our brown coals. It generally occurs in radiate spherical or cockscomb-like groups, and from its proneness to decomposition has doubtless been the cause of many of the subterranean fires which have been of such frequent occurrence in our Otago collieries. It also occurs in many of the tertiary clays, and specimens were exhibited from Canterbury by Dr. Haast in the New Zealand Exhibition of 1865 (see Jurors' Rep., p. 257).

Pyrrhotine, Fe′.—The occurrence of this mineral has been previously mentioned under the nickel ores.

Glauconite—which is a hydrous silicate of the protoxide of iron and potash, is of frequent occurrence in certain schists, and also in the greensand series (Hector, Jurors' Rep. N.Z. Ex., p. 436). It occurs as rounded grains in several of the younger secondary beds, but is more markedly developed in the Weka Pass calcareous greensand series than any other, but in this formation has a somewhat wide distribution in the colony.

Vivianite, $\dot{\mathrm{Fe}}^{8}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\underline{\mathrm{P}}}$, occurs as small prismatic crystals in Moa bones from the N. E. Valley, Dunedin, where they were originally discovered by Dr. Hector (see Jurors' Rep. N.Z. Ex., pp. 264, 436), and it has since been discovered in an earthy form imbedded in clay at Timaru; Pohangina River, Manawatu; Port Chalmers; and Taranaki. The crystallized specimens are of a deep indigo blue colour, and the earthy varieties are all bright cobalt blue.

Copperas, $\dot{\mathrm{Fe}}\dddot{\mathrm{S}}+7\dot{\mathrm{H}}$, occurs at the Thames Goldfield, and also as a product of decomposition in some of the coal mines. Its occurrence was first mentioned by Mr. Skey (Geol. Rep., 1870-71, p. 87), as occurring in a crystallized form in the Long Drive Claim at the Thames, where it is found in all the old drives and workings where the enclosing rock is, or has been, pyritous, and the presence of this mineral as pointed out by Mr. Skey exercises a very prejudicial effect upon the quicksilver, causing it to flour. The specimens in the Museum are of a bright mountain-green colour; they are translucent and vitreous, and though crystalline in character do not occur in properly formed crystals.

Delessite, *Chlorophœite*, and *Green Earth*, which are all hydrous silicates of iron, with other impurities, occur as fine earthy minerals, of a dull olive-green colour, filling cavities in the melaphyres of the Mount Somers, Rangitata, and Malvern Hills districts. They were originally detected by Dr. Haast (see Jurors' Rep. N.Z. Ex., p. 257).

Copper.

The occurrence of copper in New Zealand has been known since 1842, when the Kawau Mine commenced work on a lode of copper pyrites, and since then it has been found in various forms throughout New Zealand.

Native Copper, Cu, occurs :—1st. In plates associated with the copper deposits of the serpentine belt in Nelson. Specimens have been obtained at Aniseed Valley ; Dun Mountain ; and D'Urville Island. It has also been found at Moké Creek, Lake Wakatipu ; at the Great Barrier Island; and at the Perseverance Mine, Collingwood. The presence of copper in the Dun Mountain has been known since 1853 :—2nd. As grains disseminated through a granular serpentine at Aniseed Valley, Nelson, where the native copper forms an average of 5 per cent. of the rock mass, but the extension of the deposit has not been proved:—3rd. As fine grains in basaltic dykes which cut through trachydolerite breccias near the Manukau North Head, at which place it is of no economic value on account of the small percentage present, but is of great interest from its unusual mode of occurrence.

Cuprite, $\dot{\text{Cu}}$.—This mineral, which, when pure, contains 88·9 per cent. of copper, is only known to occur in the serpentine belt of Nelson, where it is found in various degrees of purity, containing from 10 to 88·9 per cent. of copper. As pointed out by Dr. Hochstetter (New Zealand, p. 475), the richer deposits of ore form lenticular-shaped masses, which, when followed, may increase to a certain distance, but then disappear again in a thin wedge. The most notable discovery of this mineral which has yet been made is that known as the Champion Lode, in Aniseed Valley, which was found by Mr. Stratford, a few months ago. This deposit is reported to be 5 feet in width, and is exposed on the surface for some distance. It has not, however, yet been worked. Specimens of this ore, which consist of Cuprite and native copper, have yielded as high a return as 90 per cent. metallic copper. Some rich patches of the ore have also been found at the Aniseed Valley Mine, Dun Mountain, and D'Urville Island, in each case associated with copper glance, but no deposits of any great importance have yet been met with and the ore is in all cases more or less ferruginous. No crystals of this mineral have yet been obtained, but it always occurs in a massive form. Cuprite has also been discovered at Bligh's Sound, Otago (Hector, Trans. N.Z. Inst., vol. ii., p. 378), and at Tokomairiro (Hector, Jurors' Rep. N.Z. Ex., p. 436), and is also mentioned by Captain Hutton as occurring in small quantities in a lode at the Thames, a little north of Wainui (Geol. Rep., 1867, p. 9).

Copper Glance, Cu'.—When pure, this mineral contains 79·8 per cent. of copper, and it has been found associated with Cuprite at most places where that mineral occurs in various parts of the Nelson serpentine belt. It is always in a massive form, and has not yet been shown to occur in deposits of sufficient extent to prove remunerative. The same remarks with regard to its occurrence apply as in the case of Cuprite.

Bornite, $Cu'^{3}\,Fe'''$.—Dr. Hector mentions the occurrence of this mineral at Kawau (Trans. N.Z. Inst., vol., ii., p. 375), and Professor Liversidge also mentions a specimen from Dunstan, Otago (Trans. N.Z. Inst., vol. x., p. 502).

Chalcopyrite (*copper pyrites*), $Cu' + Fe'''$.—This ore, which contains theoretically 34·5 per cent of copper, but which in nature is seldom found to have more than 15 to 20 per cent. present, and frequently less, is the most permanent form of copper ore and the one from which the greater quantity of that metal is extracted.

This mineral was first discovered at the Island of Kawau in 1842, and was worked for several years, yielding on an average 12 per cent. of copper (Hector, Trans. N.Z. Inst., vol. ii., p. 375). When the mine was abandoned the lode was reported to be 15 feet thick and to consist of a compact yellow pyrites, averaging 16 per cent. copper, lying against a band of iron pyrites. An account of the character of the lode has been published by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 375). Copper pyrites has again been worked at Mine Bay, Great Barrier Island, where it occurs associated with peacock copper, blue and green carbonate, and black oxide, but is now abandoned. It occurs in a breccia lode, and has been reported on by Captain Hutton (Geol. Rep., 1868-69, p. 4).

Another instance of its occurrence is at Moke Creek, Lake Wakatipu, where it is found in a lode 4 feet wide (Hector, Trans. N.Z. Inst., vol. ii., p. 378), in which a solid vein of Chalcopyrite from 5 to 8 inches wide occurs, the rest of the lode containing only a little copper scattered through the gangue, and it is bounded by cupriferous schists. It again occurs in a lode near Waipori, in Reedy Creek, a branch of the Waitahuna, from which locality some very fine specimens have been obtained, yielding as much as 14 per cent. of copper.

Mr. Macfarlane has forwarded specimens of Chalcopyrite from a block of land on the Paringa River, Westland, which he reports that he obtained from a lode 3 feet wide. Half of this lode is made up of the solid ore, yielding 18·55 per cent. of copper, the remainder consisting of quartz with thin bands of ore of the same kind. Copper Pyrites has also been found at the Pioneer Claim, Collingwood. Besides these localities at which lodes are known to occur, Copper Pyrites has been found at various places, such as the Thames, associated with gold; as grains imbedded in quartzose schists of the Moorhouse Range, Canterbury; in the river beds south of Mount Cook on the West Coast; in a lode at Dusky Sound, which however did not prove of great value when opened up; at Lake Ohou; and at the Perseverance Mine, Collingwood, in small quantities.

Peacock Copper, which is only a variegated variety of Copper Pyrites, often occurs with that mineral.

Malachite, $\dot{C}u^{2}\ddot{C}+\dot{H}$.—*Green carbonate of copper* occurs as thin encrusting films on some of our copper ores, and also in the cupriferous schists of Moke Creek. It never, however, is found in a crystallized form, nor in sufficient quantities to be of any value.

Azurite, $\dot{C}u^{3}\ddot{C}^{2}+\dot{H}$.—*Blue carbonate of copper* occurs even less plentifully than Malachite, but under similar conditions as a thin encrustation on some of the Nelson and Great Barrier ores.

Dioptase, $\dot{C}u\ \dddot{S}i$, occurs as an encrustation on the Nelson copper ores, and also at the Wonder Claim, Thames (Skey, Geol. Rep., 1870-71, p. 85).

Chrysocolla, $\dot{C}u\ \dddot{S}i+2\dot{H}$.—Is very common encrusting the copper ores of the Serpentine Belt in Nelson, where they have been exposed to the action of the atmosphere, and is far more commonly met with than either the green or blue carbonates.

Tetrahedrite (var. *Richmondite*), R', $\bar{R}'''$.—This ore has been obtained from a lode at Richmond Hill, Collingwood, and has yielded from some specimens as much as 1,792 ozs. of silver per ton of ore.

A complete analysis of this mineral is as follows:

Sulphide of	Lead	36·12
,,	Antimony	22·20
,,	Bismuth	traces
,,	Copper	19·31
,,	Iron	13·59
,,	Zinc	5·87
,,	Silver	2·39
,,	Manganese	·52
		100·00

Its mineralogical characters have been described by Mr. Skey (12th Lab. Rept., p. 31). It is massive, nearly homogeneous; cleavage irregular; brittle, structure confusedly crystalline; colour black generally, but in parts reddish; streak dark slate-colour; hardness about 4·5. Specific gravity 4·317. At a low heat (a little under redness) it fuses readily, and in parts intumesces considerably. The analysis gives the formula $Sb_2\ S_8$ $+6$ (Pb, Cu, Zn, Fe, Ag, S) according to Mr. Skey. This forms a valuable ore of silver, in addition to the copper which it contains.

Metallic Minerals.—Class IV.

Noble metals, reducible by heat alone.

Gold.

This precious metal is widely distributed in New Zealand, and since 1857 no less than 9,659,266 ozs., having a value of £37,810,653, has been exported from the colony. Native gold occurs both in reefs, of which there are several classes, and in an alluvial form, it being from the alluvial workings that by far the greater quantity of gold has been obtained. The goldfields have been divided on the Geological Map into Northern, Central, Western, and Southern, and the gold from the different localities varies considerably in purity. That from Otago or the Southern fields and from Westland is pure or nearly so, being alloyed with less than 6 per cent. Ag., and a little copper. In Nelson it is alloyed with 10 to 14 per cent. of silver, while at the Thames or Northern goldfield it is generally alloyed with over 30 per cent. of silver, thus corresponding in composition to the Electrum* of Klaproth, which contains gold 64, and silver 36 per cent. There is also a marked difference in the associated minerals north and south, which, of course, is dependent upon the rocks from which the gold is derived. Thus in the Southern goldfield it is associated with Platinum, Zircons, and Garnets, as well as Black Hematite and Scheelite; in Nelson it occurs with the rare minerals Osmiridium and Platiniridium, and in the Northern goldfields Native Arsenic, Copper Pyrites, Galena, Zinc Blende, and Stibnite occur in the reefs, these being also more or less represented at Collingwood and at parts of the West Coast. The different characters of the reefs and mode of deposition are, however, the most marked and interesting in different localities.

In the Southern goldfield at Macetown and Cromwell these reefs are of a truly brecciated character (Hector, Geol. Rep. 1878-9, p. 24), being composed of angular fragments of slate and schist cemented by quartz, with which gold has been infiltrated in a very pure form. The gold in these reefs must have been introduced by mechanical means, but some has probably also been deposited from solution; but these reefs which occur in metamorphic schists have probably been formed subsequently to those in the foliated schistose rocks and slates, which belong to the next group, and from which they have derived their gold to a large extent. The reefs of the Reefton district, on the other hand, are true fissure reefs, and owe their origin to fractures produced by contortion, those which occupy the synclines widening as they descend, while those on the anticlines die out in depth or come to be nothing more than strings. Outliers of the same formation of reef occur at Cardrona. These fissures having been formed by the same action which induces cleavage elsewhere, during the plication of the strata on a large scale, have given rise to subterranean channels, in which the quartz and gold have been deposited from solution. The reefs thus formed consist of solid, compact quartz, and correspond more to the Australian reefs than any others. It is hard to assign any reason for the precipitation of gold in cases of this sort, and a field of research yet remains open for anyone who feels disposed to take it up.

* Hector "Trans. N.Z. Inst.," vol. ii., p. 366.

The next class of reefs are those which occur in the vicinity of Wellington. The rocks here consist of ridges of slate and sandstone, probably of lower carboniferous age, and these have been traversed by a series of dislocations which cross the lines of stratification obliquely. The consequent displacement appears to have indurated the sandstones and altered the shales, when in contact with them, into friable cherty slates of a deep-blue colour, traversed by thread-like veins of quartz (Hector, Trans. N.Z. Inst., vol. ii., p. 368). These movements, when deep-seated, would doubtless be attended with the evolution of steam under great pressure, which would, by traversing the cracks, carry up with it in solution whatever minerals were present, and subsequently deposit them, not as they are now found, but as quartz with pyrites, which would be more or less auriferous according to circumstances. When by subsequent denudation these deep-seated veins were brought under the action of the atmosphere, a decomposition of the pyrites would ensue and free gold be left in the veins in the manner in which it now occurs. In addition to the gold derived from the auriferous pyrites, some must have been deposited at once in its native condition or have been subjected to re-solution and precipitation, as it is commonly found in a dendritic form.

The last class of gold-bearing reefs are those of the Thames and Coromandel districts, from which the greatest quantity of reef gold has hitherto been obtained. These are of extreme interest as regards their mode of occurrence. The rocks which form the matrix of these reefs are of volcanic origin, and consist of various classes of a felsitic rock, more or less decomposed, through which pyrites is very freely scattered. It appears to be more or less allied to the "propylite" of v. Richtofen, and has been called "tufanite" by Dr. Hector. These rocks rest unconformably upon the slates which form the basement rock of the Cape Colville Peninsula, and are in their turn overlaid unconformably by dolerite floes, and coarse volcanic breccias and tufas, with which are associated irregular seams and patches of coal. The whole series appears to have been tilted along a north-east line, the force which thus tilted the beds having produced a series of fractures, which, by the subsequent sinking of the hanging wall, have been opened and formed subterranean water-channels, thus affording an underground drainage to the country. Water percolating through these drains has deposited quartz and, under favourable circumstances, gold from solution, and this gold is found, sometimes disseminated through the compact portions of the stone as minute specs, and at other times entangled in a crystalline or dendritic form where the quartz is open in texture. In the latter cases, more especially in vughs in the reefs, the gold is frequently associated with Native Arsenic and Sulphides of Copper, Lead, Zinc, and Antimony.

The presence of gold in these reefs appears to depend upon a variety of circumstances which are not yet thoroughly understood; I may, however, mention a few essentials which have been observed. The first of these is that the reefs should be passing through moderately hard compact country, and where this is traversed by thin black pyritous veins which junction with the reef, the character of the country may be looked upon as more favourable. Where any reefs are found passing through this class of country they are generally more or less auriferous, and this is specially noticeable in the large reefs of the district. There are, however, in addition to the large reefs, innumerable small leaders, from $\frac{1}{16}$ inch thick up to a few inches, which, while following approximately the same strike as the other reefs, are as a general rule somewhat steeper; and where these junction with the main reefs in favourable country, very rich deposits of gold are frequently met with. Besides these hanging-wall leaders there are also many droppers from the foot-walls of the reefs in which also rich gold is often found, and they give one the impression of being leaks, if I may use the term, from the main reef, by which some of the gold has escaped.

The character of these deposits points most conclusively to the fact that the greater quantity of the gold in the reefs was deposited from solution, and the fact of the junctions of different leaders making the gold, leads one to believe that it was only where two streams, carrying the necessary ingredients in solution, met and mingled that any precipitation of gold ensued and a deposit of the precious metal was formed.

There are many other points bearing upon the behaviour of the reefs which are of great interest, but which it is not my province to discuss here.

That all the gold in these reefs is not derived from the same source, is I think, however, apparent, for that which is crystallized or occurs in dendritic forms, would owe its origin to super-heated steam, in the same manner as the last described set of rocks, and the description of gold with native arsenic from the Kapanga Mine, Coromandel, which will be found under the head of arsenic, offers a very striking illustration of this.

With regard to alluvial gold but little need be said. The principal alluvial fields are those of Otago and the West Coast, with some smaller but still important ones in the Nelson district, and the alluvial gold partakes of the same characters as that obtained from the reefs. Large nuggets are rare, indeed the largest which has been obtained is one from Rocky River, Collingwood, weighing 10 ozs., and another from the same locality weighed 8 ozs. These are mentioned by Dr. v. Hochstetter, (New Zealand, p. 100.)

Gold is also obtained from what are known as the Cement workings, at Tuapeka, and elsewhere. These cements consist of heavy gravels which have been consolidated, and are the remains of an old glacier or glacial river, which flowed across the country in quite a different direction from what the drainage now follows, and remnants of these old deposits yet remain. The cross-drainage which now prevails, has removed large tracts of these cements, and, by a process of natural sluicing, concentrated the gold in the beds of the creeks, some of which have proved fabulously rich. For a description of all these workings and the different characters of the alluvial deposits, I must refer the reader to the "Manual of the Mineral Resources of New Zealand," by Dr. Hector, now in course of publication.

Platinum.

Native Platinum, Pt, Fe.—This metal has been found in a native state in small flat grains of a steel-grey or silver-white colour, associated with gold in alluvial deposits at Stewart Island, and with Zircons in the gold-wash of the southern goldfields. It is also found under similar conditions at the Collingwood goldfield, Nelson, but it has never yet been discovered in a reef (Hector, Trans. N.Z. Inst., vol. ii., pp. 185, 371; Jurors' Rep., p. 403).

Platiniridium, Pt, Ir.—Grains of this rare mineral have been obtained from the gold-wash of the Takaka diggings (Hochstetter's New Zealand, p. 107).

Osmium and Iridium.

Osmium-iridium, Ir, Os, also occurs in the gold-wash of the Takaka diggings as small flat grains, which are of a brighter colour and less malleable than Platinum. They are mentioned by Dr. v. Hochstetter (New Zealand, p. 107) and Dr. Hector (Jurors' Reports, p. 403; and Trans. N.Z. Inst., vol. ii., p. 371).

Silver.

But very little silver has yet been obtained in New Zealand except that alloyed with gold, in which form, at the Thames, it occurs abundantly, and as a component of the Tetrahedrite (Richmondite) of Richmond Hill, Collingwood, in which silver occurs in variable quantities up to 1792 ounces per ton. It also occurs in all the Galenas in greater or less quantities.

Native Silver, Ag, has been found as small rolled fragments in the Kawarau and Wakatipu Lake diggings, and also at Waipori (Hector, Jurors' Reports, p. 403, 436).

Argentite, Ag'.—Mr. E. H. Davis mentions the occurrence of a sulphide of silver at the Silver Crown Claim, Thames (Geol. Rep., 1870-1, p. 61), and a specimen is now in the Museum from that locality. It consists of a blackish-grey powder, and as Mr. Davis gave no description of its mode of occurrence I am unable to cite it.

Pyrargyrite, Ag'^{3} Sb'''; *Proustite*, Ag'^{3} As'''.—It is probable that one or other of these minerals occurs at the Thames, as Captain Hutton's mention of the occurrence of "red oxide of silver" at the Golden Crown Mine (Geol.

Rep., 1870-71, p. 5), is probably a misprint, no such mineral, as far as I am aware, being known. He also, page 148 of the same volume, without description, mentions the occurrence of "oxide of silver, and probably sulphate of silver," from the new Golden Crown Claim, but as neither of these minerals are mentioned in Dana's mineralogy, I am unable to say to what he refers.

MERCURY.

This metal has been found in New Zealand, both in the native state and also as Cinnabar, but only so far in small quantities.

Native Mercury, Hg, occurs at Waipori, in the district of Otago, where it is found in the alluvial wash of the district as small globules, and also alloyed with gold to form amalgam (Hector, Jurors' Rep., p. 404). Native mercury also occurs at the Ohaeawai Springs, near the Bay of Islands, but only in small quantities. It has been known since 1866, and in 1870 Captain Hutton described a visit to the locality (Trans. N.Z. Inst., vol. iii., p. 252), and the mode of occurrence has since been described by Dr. Hector (Geol. Rep., 1874-76, p. 5), as follows:—"The Ohaeawai Springs deposit a brown sandstone, which forms laminated beds 10 feet to 15 feet in thickness. This sand, which is an incoherent granular siliceous deposit, includes fragments of the surrounding vegetation, and thin layers of Cinnabar sand and globules of Metallic Mercury. The layer of sandstone containing mercury is only 4 inches thick, and is confined to a very limited area, and the attempts made to collect the mercury have not, hitherto, been profitable."

Cinnabar, Hg'.—This mineral occurs as rounded grains in the alluvial deposits of the Obelisk Ranges, Potter's Gully, Dunstan, Serpentine Valley, and Waipori, in Otago (Hector, Jurors' Rep., pp. 264, 436), and also in the deposits of the Ohaeawai Springs previously mentioned.

ART. LXXIII.—*On Crystalline Rocks.* By W. D. CAMPBELL, F.G.S.

[*Read before the Auckland Institute, 11th July,* 1881.]

CRYSTALLINE rocks occur as altered sedimentary deposits, and comprise most of the eruptive rocks; the latter are to a great extent crystalline at the time of their formation, while the former were originally loose accumulations of various particles for the most part. Both kinds of rocks are subject to changes of condition which are termed metamorphism, by which the internal texture and composition have been altered gradually by chemical, electric and crystallographic action, by the withdrawal of, or addition, or substitution for some of the chemical elements, aided by heat and watery vapour acting under intense pressure. The changes in the sedimentary rocks are usually more apparent than in the eruptive, so that the term metamorphism has been more especially applied to these rocks.