reached, many men seem to get tired of good healthy work, and instead of exploring fresh fields go over the old, and keep magnifying minor differences into groups of families, to the complete confusion of everything; forgetting that the great aim of all science is simplicity, and the more simple a science the grander and nobler it is.

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ART. LII.—*On a New Form of Iron Pyrites.* By E. H. DAVIS, F.C.S., F.G.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, September* 17, 1870.]

IRON PYRITES has long been known as a dimorphous mineral, occurring crystallized in the tesseral and rhombic systems; the latter variety, called marcasite, occurs as a right rhombic prism $-\infty$ P 106° 5′, brachydome $\frac{1}{3}\overset{o}{\text{P}}\infty$ 136° 54′, brachydome P$\infty$ 80·20 and a macrodome $\bar{\text{P}}\infty$ 64° 54′ combined. The other form is common in cubes $\infty$ O $\infty$, octahedron O, and several semitesseral forms, the pentagonal dodecahedron $\frac{\infty O2}{2}$ the hemihedral form of the tetrakishexahedron, rarely tetrahedral; a common combination is that of the pentagonal dodecahedron with the octahedron, the faces of the latter replacing the trigonal angles of the dodecahedron. Macles are common, but are not material to the present purpose.

Plate XXVI., fig. 7., is a new form from the Chatham Islands. The lustre, specific gravity, and hardness, are the same as the common varieties; the system is oblique, nearly isomorphous with felspar, but having the clinodiagonal longer; the faces, which are smooth and brilliant, are $\infty$ P prism (*P*), OP clinopinacoid (*M*), P hemipyramid (*a*), *n*P$\infty$ hemidome (*d*), (*n*P$\infty$) clinodome (*n*).

The thick lines show where the crystal is cut off.

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ART. LIII.—*Remarks on the Resemblance of the Country in the neighbourhood of the Dun Mountain, and Wairoa Gorge, to the Mining Districts of Queensland and Auckland.* By W. WELLS.

[*Read before the Nelson Association for the Promotion of Science and Industry, April* 6, 1870.]

IN bringing the subject of the present paper before the Association, I will at once state that I am indebted for the facts contained in it partly to my own observation, but more particularly to communications received from Dr. Hector, Mr. T. R. Hackett, and, latterly, to a very able report on the Rockhampton gold-mining district in Queensland, by Mr. Daintree, the Government Geologist of that colony.

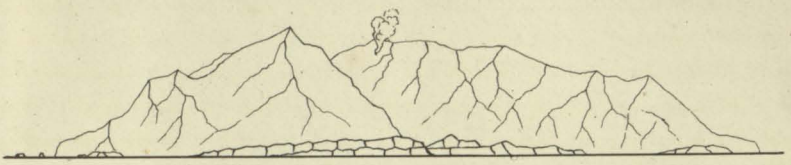
These communications and observations all tend to show an almost perfect similarity of the country to that part of the Province of Nelson which lies between Motueka Gorge on the south, and D'Urville's Island on the north, the centre of which may be said to be the Dun Mountain.

Dr. Hector writes me as follows:—"I have just received a series of specimens of the gold-bearing rocks at Gympie, from Mr. Hackett, Queensland, and from their characters I have no doubt of their similarity to the Wairoa Gorge rocks and to some extent also to those at the Thames diggings. They have all the appearance of being true greenstones, and yet contain *Spirigera*, *Monotis*, and other Trias fossils; they are charged with pyrites, and cut by quartz reefs; and many of the specimens cannot be distinguished from those sent by Captain Hutton from the Thames. One specimen contains graphite markings, and resembles closely the plant-beds from Wakapuaka."

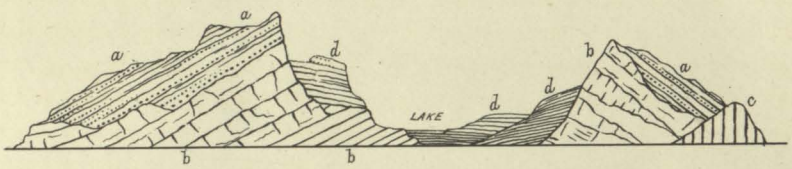
Mr. Hackett remarks on the similarity of the Dun Mountain country to that of the Rockhampton gold-mining district, as containing chrome ore, serpentine, gabro, schiller spar, copper ore, and iron ore; and in a previous letter, dated "Gympie," he writes:—"The new reef at Killiven, the place I wrote you of as being similar to the Dun Mountain, is turning out well, viz., ten ounces to the ton, where nothing is visible to the naked eye;" and he adds, "the Dun Mountain people ought not to be discouraged."

In Mr. Daintree's report, I wish to draw the attention of the members of the Association to a new and remarkable feature in gold-mining, as presented to us in that report, viz., the fact that it is no longer a necessity in searching for gold that we should first discover either quartz veins or quartz reefs for a matrix, and that it is now proved beyond a doubt that gold exists in rock masses in Queensland, both of felspar and serpentine.

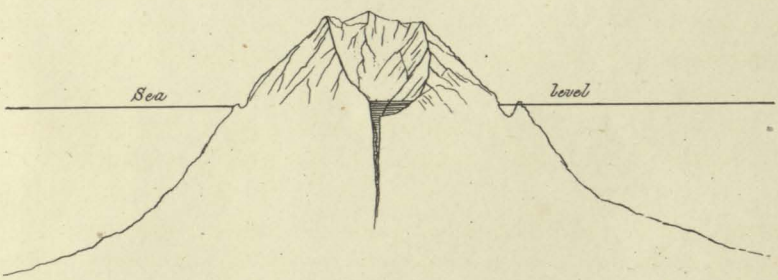
Mr. Daintree, in his report, says:—"There are other matrices of gold, by no means self-evident, which call for more careful consideration as likely to yield most valuable results. These are—The auriferous serpentine rock of Block's claim, Mount Wheeler, and the auriferous felspar of Cummins's reef. In my report on the Cape River District, some twelve months since, I drew attention to the fact that the gold of Paddies' and Sharpers' Gullies had evidently been derived from a decomposed felstone dyke and not from quartz veins, and suggested that some of the upper portions of our felspathic 'dykes' might be remuneratively worked for gold. In the case of Cummins's reef, we have confirmatory evidence of this fact. This material, which has yielded, continually, half an ounce to the ton, is simply a crystalline pyritous felspar rock, about ten feet thick, bounded by greenstone walls, and whether considered as a 'dyke,' or the segregation in a particular zone of one element only of the boundary rock, adds to the conviction that we are at present entering on a new field in the occurrence of gold, the importance of which cannot be over estimated." "The auriferous serpentine," Mr. Daintree remarks, "of Block's



*From S.W.*




*Section through the Lake.*




*Probable form below Sea level.*

# WHITE ISLAND.

J.Hector del. J.B. lith.

Printed at the Gov. Gen. Lith. Press

claim, Mount Wheeler, is a speciality hitherto unobserved, where the gold is absolutely quarried from the rock-mass, and there is no appearance of vein-stone in any way different to such rock-mass. On crushing and washing it yields, besides fine gold, chromic and titanic iron sand, so does (with the exception of the fine gold) all the serpentine from Mount Wheeler to Maryborough. At old Canoona, the evidence is all in favour of the same mode of development of the precious metal as at Block's claim. The bed-rock is serpentine—there are no quartz reefs, but where a matrix is found adhering to the alluvial gold it is serpentine, and, in addition, chromic iron sand is abundant in the drift. A fragment of mineral which appears to be decomposed serpentine, was lately forwarded to me by Mr. Josephs, the well known assayer, of Gympie, which was coated with carbonate of copper, and the locality from which it came had been taken up for copper mining, yet this, on assay, had yielded more than forty ounces to the ton. It may therefore be fairly concluded that serpentine rock may for the future be considered a field for the prospector, whether it be associated with quartz or not."

"These various novelties," adds Mr. Daintree, "in the occurrence of gold, enlarge considerably the supposed mineral areas of Queensland, and will lead to the careful prospecting of country which the Southern miner at all events would previously have passed over, and may in course of time, as our miners find their way South, lead to the opening up of gold fields where the surface rock formation has hitherto been considered unfavourable to the occurrence of the precious metals."

Another quotation from this report, as showing a very great similarity to the Dun Mountain and Wairoa Districts; Mr. Daintree, in describing Mount Wheeler, says:—"Chromic iron and chromic ochre are distributed over this serpentine country, and with a small proportion of titanic iron form the black sand so troublesome to the diggers. Very numerous outcrops of copper ore have been discovered in this district, which may be divided into three classes: —first, those derived from the decomposition of their pyritous veins, carrying a small amount of copper, which by decomposition and re-precipitation has impregnated the joints and cavities of the boundary rock to varying depths with earthy blue and green carbonate. This class of vein is, however, generally represented on the surface by a hard iron band, stained and coated with copper ore, but is more worth prospecting for gold than copper."

On this similarity I may remark, that it was the discovery of these iron copper-stained bands by Mr. Travers, on the Dun Mountain, led, as you are aware, to the formation of a company for prospecting and working the supposed copper lodes which the district contained. These iron copper-stained bands were first prospected by Mr. Wrey, and subsequently followed up by driving on their course, sinking by shafts, and cross driving, under the direction of Mr. Hackett, but without any result, except the picking out, now and again,

of a few small bunches of ore of variable quality, apparently precipitated into the crevices of the serpentine by solution from the decomposition of the outcrops of the neighbouring dykes, which run through that district in a course north and south. These bands in the Dun Mountain are of a similar character to those which Mr. Daintree remarks are more worth prospecting for gold than for copper; so it is just probable that, had the attention of the Dun Mountain Company been directed to the precious metal instead of copper and chrome, the results might have been very different.

The second class of veins, where the rock itself is pyritous, and the decomposing pyrites stains the joints and cavities with copper ore, sometimes for a considerable distance from the source of the ore itself. This mode of occurrence may be sometimes considered as a zone of impregnation, for, often a definite course can be assigned to a series of such outcrops. Two-thirds of the surface indications which have been discovered in the district have originated in this manner. The third class of veins are deposits of true copper ores in a matrix of quartz, calcspar, etc., with at least one defined wall, promising to become in depth true "lodes." The Pioneer Company's lode, at Collingwood, seems to belong to this class, showing a grey sulphide, and copper pyrites, in a quartz matrix, which has been tested with favourable results.

The foregoing quotations and remarks have been principally directed to the serpentine country. I now proceed to make a few observations on that section of country bounded by the serpentine on the east, and Blind Bay, as a likely field for the prospector for gold. This section may be said to rest on the Maitai slates. The slates run in a N.N.E. and S.S.W. direction, and are intruded upon at various points by greenstone dykes, and showing in their outcrop small quartz veins, such as are seen at the upper foot-bridge across the Maitai, within the boundary of the city, and said to contain gold. Several veins are also observable higher up the valley, as well as at various points on the line of the Dun Mountain Railway, where greenstone dykes, intersected by quartz veins, occur.

This class of country, Mr. Daintree remarks in his report, is highly favourable for gold-producing reefs. He says, in his report on veins entirely in greenstone:—"The mines Maria Louisa, Ball, Original Homeward Bound, and all the Crocodile District reefs, belong to this class. In Australia," he continues to say, "so far as I can learn, this mode of occurrence of auriferous veins has only been practically tested in Queensland. By personal inspection, I am aware that all the mines opened in the Black Snake District, near Kikivare, take their course through porphyritic greenstone, and some of the Gympie reefs are said to be so bounded." The peculiarity of veins of this character, he says, seems to be "that all yet tried have been proved to be auriferous, but associated with such an amount of sulphides as rather to deserve the name of 'pyrites lodes' than quartz veins."

The Thames gold field, in the Auckland Province, presents also a very great similarity to the Nelson section of country to which I have been alluding, being characteristic of intrusive diorite or greenstone dykes with quartzose veins highly impregnated with sulphides.

From the foregoing remarks, it will be seen that gold is found in rock masses, such as in the serpentine at Mount Wheeler, without any appearance of quartz veins, the matrix apparently being the mass rock itself; also, that the Maitai country is of the same age and character as the gold fields of Queensland and the Thames, from a comparison of the fossils and rock specimens by Dr. Hector and Mr. Hackett. These facts, I think, at least warrant us in presuming that the district in our immediate neighbourhood requires a much more careful prospective search than has yet been bestowed upon it.

I have directed the attention of parties connected with the Dun Mountain Company's estate, respecting the analogy between their property and gold mining fields elsewhere; and would advise parties who may have occasion to traverse that part of the country lying between the head waters of the Motueka River and D'Urville's Island, to look out for anything of the character of lode stuff, so that it might be tested for auriferous deposits. Serpentine shows in great force all through this district, and exhibits about the same strike, angle, and dip, as the auriferous serpentine reefs at Mount Wheeler.

Mr. Daintree publishes a table, giving the yield of gold per ton in the different districts embraced in his report, of which I have taken a summary extract, as follows :—

Mount Wheeler District—Serpentine, with pyrites. Five mines at work, yielding from 4 dwts. to 3 ozs. per ton.

Mornish District—Greenstone and sandstone, with copper and iron pyrites. Six mines at work, yielding from 7 dwts. to 4 ozs. per ton.

Blackfellows' District—Sandstone and slates, with copper and iron pyrites. Six mines at work, yielding 1½ oz. to 11 ozs. per ton.

Crocodile District—Greenstone, with copper and iron pyrites. Five mines at work, yielding from ½ oz. to 4 ozs. per ton.

You will observe that the presence of pyrites is a marked feature in all these mines, the treatment of which has always been a difficulty with the gold-miner. On this subject, Mr Daintree remarks as follows :—

"With the increasing depth of the mines the quantity of free gold diminishes, and that of the pyritous gold augments; so that greater attention must be directed to this branch of metallurgy of gold, or many good mines will have to be abandoned in consequence. In Victoria, this subject has been under the serious consideration of the owners and managers of most of the crushing machines, and general success seems to have been achieved both in

the saving of and the extraction of gold from the pyrites. The principles of the process are—

"1st. Concentration of the ore.

"2nd. The roasting-sweet, or until all the sulphur has been drawn off, and oxides only remain.

"3rd. The amalgamation of the roasted mass in a semi-moist state by trituration, and the collection of the finely divided amalgam by means of an additional large amount of quicksilver and water, and ultimate washing off. The saving and concentration of the pyrites is the most difficult operation, on account of the slight difference in specific gravity between the material to be saved and the quartz and other associated earthy matter. It has, however," Mr. Daintree observed, "been accomplished with tolerable success by Mundy's Patent Buddle, Stanfield's Patent Concentrator, and Thompson's Patent Percussion Table. Mr. Ulrich also recommends, as more perfect for this purpose, the Self-Acting Hydraulic Digging Machine, which he saw at work in the Hartz Mountains, and in the principal districts in Germany."

The roasting of the ore is effected in large reverberatory furnaces. One with special arrangements for this kind of work, patented by Mr. Lata, in use at the Port Phillip Company, at Clunes, is highly recommended.

For accomplishing the third operation, an "arrastres" is employed. Great care should be taken that for the trituration with quicksilver the stuff is not too moist.

With regard to saving the fine free gold generally associated with pyrites, and of which, on the latter account, there is no doubt a large amount lost in the tailing; Mr. Ulrich recommends the Tyrolese gold mills, which, on a recent visit to Europe, he saw at work in the celebrated gold and silver mining districts of Schemnitz, in Upper Hungary. These mills, which require but little attention and power to work, save gold too fine to be seen with the naked eye, from an ore composed of galena and iron, and copper pyrites, and are successful with even so little as two to three dwts. per ton.

I have brought this subject before the notice of the Association in rather a loose and unconnected form; but as the attention of prospecting parties has lately been turned to the Maitai Valley and neighbouring country in search of gold, I have some hopes that the facts and somewhat new features which exhibit themselves in the gold-mining districts of a neighbouring colony, under features almost identical with our own district, may be of some use in directing the search.

[In consequence of remarks in the above paper, both the cupreous and chromic iron ores from the Dun Mountain were analyzed, and in both, distinct, though small, quantities of *gold* were detected. From 120 grains of the former, the amount obtained is visible to the unaided eye.—J. Hector.]