THE "IRON BLOW" AT THE LINDA GOLDFIELD.

By G. Thureau, F.G.S.

In the recently issued printed Papers and Transactions of the Royal Society of Tasmania, on page 216, are published some notes by Mr. R. M. Johnston, F.L.S., an esteemed member of the Society, on the "Iron Blow" at the Linda Goldfield, his conclusions having been based upon the examination of some rocks and specimens from that locality received from Mr. Crotty and Mr. Belstead, the Secretary for Mines.

It is upon that remarkable gold-deposit that I desire to offer a few remarks, at the same time embracing the opportunity of supplementing and elaborating my report, No. 146 of 1886, presented to Parliament.

In the following remarks, I shall exclusively confine myself to the question of the probable origin of this unique gold formation in furtherance of my theory of its being due to "volcanic agency," and not, as Mr. Johnston contends, to local decomposition, especially so far as the dark coloured and pulverulent masses are concerned. I may likewise observe that in my report to the Government such questions as these concerning and referring solely to the more scientific aspect, must of necessity be very brief, because the larger questions as to the present or ultimate value of any mineral or metalliferous discovery, are of more immediate practical value as affecting directly the progress of the community at large.

In the first place, it appears that the Secretary for Mines obtained the specimens in question from Mr. Crotty, the discoverer of that "Iron Blow." Subsequently, Mr. Johnston, aided by Mr. Ward, the Government Analyst, concluded that the soft purply black and so highly auriferous mineral was the result of decomposition of some of that immense bed or vein of solid pyrites (iron) filling the greater width of the fissure on its "hanging wall," or about 225 feet out of a total width of 280 feet between walls of that chasm.

Dismissing all speculations as to whether it has been prudent to base any reliably practical opinion, such as to the question of origin of that valuable deposit, upon the examination of "specimens" only, even though, such was to some degree supported by chemical analyses, it further appears from the late Mr. C. P. Sprent's report that, but a very cursory examination of that deposit, *in sitû*, had been made during that gentleman's and associates' tour from the Ouse

to the West Coast. Thus, on the whole, a settled and reliable opinion as to the causes governing the past geological history of the "Iron Blow," accounted for by Mr. Johnston as a process of decomposition of materials at hand, in opposition to the theory of volcanic agencies which I have advanced in my report, deserves to be treated in detail, as involving important issues.

Decomposition is, I believe, a chemical process by which the destruction of one or more substances leads to the substitution and depositing of quite different matters, thereby bringing about the rearrangement of the former original substances in quite different forms.

In this case it has been attempted to be proved that those massive beds of pyrites on their decomposition from local causes, were replaced by that highly interesting pulverulent mass reported so rich in gold. Now, I have before me two letters from the Government Analyst, viz.: one dated November, 1824, and the other October, 1885, in which the results of the analysis of "solid pyrites" from that "Iron Blow" are given thus:—In the first letter Mr. Ward states: "I have carefully tested the minerals received . . . . have not been able to detect the presence of tin or any other metal of commercial value;" in the second he says: "In none of the samples forwarded for assay have I been able to find more than *traces* of gold." To these may be added those examples cited in Mr. Johnston's paper, viz.: No. 9, "A sample of Iron Pyrites in which gold is not mentioned as being present, and in No. 7 the sample only shows "fine specks of gold just visible to the eye," but this is not from pyrites, but from the soft purply pulverulent mass, which is about 56 feet wide.

On page 219, the author states: "Whether we suppose that the 'Iron Blow' is due to hydrothermal agency or not, there is nothing in the composition of the iron pyrites or the dark purplish rock which necessitates their having been originally formed in the way of *volcanic mud*." It is more probable that the four principal elements, iron, barytes, sulphur and gold, were originally precipitated from solution."

Leaving out the references made in the paper in question as to the production of gold elsewhere as foreign to the subject under discussion, and which, however, are not altogether accurate, I beg to direct your attention to the facts upon which I join issue with Mr. Johnston's theory of origination.

The analyses of Mr. Ward, cited by Mr. Johnston and myself, conclusively prove the almost total absence of gold in the pyrites, veins, or beds, which may be described as very dense and excessively solid, and which undoubtedly have resisted both decomposition and dissolution for ages; how is

it possible then, I may ask, that these almost *non-auriferous* iron bi-sulphides produced on their supposed (inert) decom position that peculiar purple mineral, assaying, as reported, considerably above 170ozs. of gold per ton? Again, those so very solid pyrites contain no barytes, which latter minerals I first discovered as the necessary adjunct to the gold. "*Ex nihil aut nihilo fit.*"

It may also be fairly questioned how it is that these veins or beds of pyrites, so dense in character, must have un doubtedly withstood atmospheric influences for immeasurable periods, on decomposition (?) filled, with new substances resulting from that process, over 50 feet in width by over a mile and a half in length, and to unknown depth of an open fissure with a "*solution*" only. Such a fissure or chasm would have collapsed at the sides long before the decomposition process had even been initiated, as the adjacent and super-incumbent rocks could not have withstood the lateral and vertical pressure their own great gravity would produce, had not the walls of that fissure been kept apart by some *heavy* filling material of a homogenous kind, exerting in itself a sufficiently powerful resistance to the overhanging walls of this fissure.

Supposing, however, decomposition was the cause and effect of this rich aggregation of minerals and metals, or, in the authors own words: "That it (the Iron Blow) is the result of oxidation of pyrites similar to that now so largely associated with it; the hydrated oxide first formed, being subsequently metamorphosed sufficiently to get rid of its *combined vapour* and produce the slight change in the form of *disseminated particles of barytes*, as revealed by the microscope; or, this process may have occurred during the process of oxidation," etc., etc.

It will therefore be necessary to bear in mind that, as proved from analysis, we have, firstly, a nearly non-auriferous bi-sulphide of iron (pyrites) to deal with, containing *no* baryta to speak of; and secondly, that water is assumed to have produced the rich pulverulent gold rock by means of the decomposition of the former, and contemporaneously or subsequently by means of infiltration filled the fissure, and that *small* (?) disseminated particles of baryta appeared either before (whence?) or during the process of oxidation.

Now, it is a fact that baryta is the "*matrix*" of that purple rock, exceeding "thirty (30%) per cent. of the whole of the vein-matter, being disguised by coatings and linings" of specular iron, and exhibiting gold in fine crystalline and filagree forms; that auriferous rock likewise exhibits a distinctly recognisable vesicular structure, the cells and cavities being now, however, filled by means of similar rock of a

denser kind and of a darker colour, as, in all probability, the result of these ore-deposits having become saturated with steam or hot-vapours, and by means of segregation and expansion of these high-pressure volcanic emanations, the cavities or cells were firstly formed and subsequently filled, thus explaining the so-called "*schistose*" appearance, which, from all appearances was principally due to the gradual cooling of a seething mass of volcanic mud or ash which was ejected in combination of several kinds of metallic vapours, such, as for instance, specular iron, which not only forms a conspicuous constituent of that volcanic material, but also occurs quite frequently in the wall-rocks of that immense fissure. In my opinion everything in connection points to a more drastic process of origination than simple and quiescent decomposition only.

That there is strong evidence of the former ebullition and belching forth of metalliferous and mineral vapours at high temperatures within certain ejective points of discharge with the volcanic muds and ashes, is clearly demonstrated by the occurrence of elongated or spherical nodules in these muds and ashes, which nodules on examination are found to contain, within hard crusts of "Limonite"—sesqui-oxide of iron—nuclei of pure iron pyrites, thus pointing the way how the decomposition of pyrites under precisely similar circumstances has actually occurred, and caused the formation of a secondary and hydrated iron ore, and not of *purple rock*, though in very close contiguity to the massive pyrites vein and beds referred to. Those nodules, it is submitted, present, neither more nor less, former gaseous bubbles surcharged with vaporous sulphuretted solutions of iron, becoming rigid when nearer the cooler atmosphere, and which from compression by the surrounding muds, etc., assumed their present characteristically elongated forms.

When it is borne in mind that geologists have concluded that "the nature of vapours evolved depends on the temperature or degree of activity of the volcanic orifices; chlorine and fluorine emanation indicating the most energetic phase of eruptivity, sulphurous gases, a diminishing condition and carbonic acid (with hydro-carbons) the dying out of that activity, and that sublimed by volcanic heat or chemical reactions, causing the decomposition of metals and minerals from condensing vapours along crevices and surfaces wherein they reach the outer air and are cooled; and further that, besides sulphur there are chlorides, and in a lesser degree, iron, copper, and lead; also free sulphuric acid, sal amonia, specular iron, oxides of copper, boracic acid, alum, sulphate of lime, baryta and others, are formed whilst at very high temperatures, and in connection with simultaneously en-

gendered electric currents" it becomes clear to the close and careful observer of these unique gold deposits, *in sitû*, that dynamical geology can alone account for these, strictly speaking, volcanic products.

Having myself had opportunities for examining active "*mud volcanoes*" in 1877, near Carson City, State of Nevada, U.S.A., these "Steamboat Springs" were most interesting, and I can therefore speak with some authority upon the subject. There, as is held by American geologists, these volcanic "vents" occur on the line of continuation of the famous Comstock Lode (silver-gold), and each spring or geyser is indicated at the surface to the visitor, at a distance by a thin column of white steam. When more closely approached, it is found that the discharges of heated mud and vapours are intermittent, and that previous to each of such discharge a greyish semi-liquid mass rises slowly within the mouth of the "fumaroles" below, and on reaching the top of the respective orifices, the carbonic, sulphuretted and other gases encompassed beneath, cause, through pressure, a dome-like expansion of the "volcanic mud," which, however, with increasing subterranean pressure eventually bursts, and allows the "mud" again to subside. Each discharge, it is noted, however, leaves a thin deposit or lamina in the "cups" at the surface, which, after hardening, was found on analysis to be chiefly charged with silica (quartz), and to also contain a sensible percentage of gold and silver. This process is even now in active progress, and as it assimilates a great deal to what can be seen in its "*dead state*" at our "Iron Blow" —if baryta is substituted for silica as matrix in the latter case —the question of origin as to both metalliferous deposits is not only, in my opinion, very suggestive, but forms the only possibly true solution of the case.

By way of further analogy, I would likewise draw attention to the fact of Senor Santos having found "Lead" in the "volcanic ash" from the eruption of Cotopaxi, of August 23rd, 1878, and in a paper read before the Royal Society of England, on January 6th, 1887, Mr. J. W. Mallet, M.D. and F.R.S., etc., reports upon the "Occurrence of *Silver* in Volcanic Ash, from the Eruption of Cotopaxi, Ecuador, of July 22nd and 23rd, 1885."

A condensed extract may prove of interest:—He, Dr. Mallet, received a specimen of volcanic ash from Senor Julian R. Santos, of Ecuador, which was collected at his residence, Bahia de Caraguez, about 102 miles nearly due west from Cotopaxi. This is the highest and most mighty of the active volcanoes of our globe; it erupted on the 22nd of July, and the ash began to fall at Bahia de Caraguez next morning, to a depth of several inches, thus representing an

enormous discharge of volcanic and metalliferous as well as mineral matter. The specimens consisted of *a finely divided powder, mobile and soft to the touch, brownish grey in colour.* Under the microscope, the following minerals could be distinguished in the granules and spicules, viz.: quartz, two felspars (one white and one pink), augite, magnetite (strongly magnetic, and scales of deep red *specular iron* oxide. After subjecting this ash to several experimental tests, it was, as a preliminary, found to possess a specific gravity of 2·64 at 18° C, as compared with water at the same temperature. An analysis of the material taken, as a whole, *i,e.*, without any previous mechanical separation of its constituent minerals, and without previous digestion with water or acid, but dried up 100 C., gave no less than sixteen separate ingredients, amongst which were traces of silver. That metal was subsequently obtained by *wet* assay; and it was also afterwards found that it could be obtained from the *ash* by furnace assay—fusion with pure lead carbonate, sodium carbonate and a little cream of tartar, and cupellation of the lead button so obtained or produced, which gave a minute bead of metallic silver; the same reagents were tested in larger quantities, *leaving out the ash*, when negative results followed. It was subsequently ascertained that silver could be extracted from this volcanic ash by boiling it with a solution of ammonia, or of potass, cyanide, or of sodium sulphate."

The discovery of silver in the ash or mud, adds, for the first time, this metal to the list of elementary substances observed in the materials ejected from volcanoes, and the addition derived some special interest from the fact of this ash having come from the greatest volcanic (active) vents of that great "*argentiferous*" zone of the Andes. Small as would be the proportion of silver, it must represent a very large quantity of that metal ejected during the eruption, in view of the vast masses of volcanic ash, etc., distributed over the large area which is indicated by the fall of argentiferous ashes at a distance of 102 miles from the central crater to Bahia de Caraguez.

There cannot be, it is submitted, much difference of opinion that, if silver, lead, iron, manganese, titanium, chlorium, mercury and other less important metals occur in volcanic ash or mud shown by frequent analyses, as derived, *inter alia* from the immensely rich argentiferous formations which that gigantic "vent" cotopaxi protrudes; a similar occurrence here on a smaller scale, within a well-known "*auriferous zone*" is not only feasible, but can be, or is now, demonstrated to be a fact. The only, and to us most valuable difference, is, that the South America ejecta expelled the silver in its ashes, whilst, with our "Iron Blow" the ash or

"*mud*" is *still retained* within the "dead" vent or closed fissure, and happily for the colony at large, it is comeatable, and it can be extracted by future systematic mining operations, followed by skilful treatment for the rich gold it is reported same contains.

With regard to the opinion I have had occasion to express in my report to the Government, I may add that the mining operations carried on since still expose rich ores at times, and as Mr. Johnston concludes his Paper by saying: It—the hydrothermal theory—had also been adopted by Mr. Thureau in respect to such mineral formations as the Iron Blow at the Linda, although the latter "seems to be unaware of the fact that the mode of origin of the more common quartz reefs are also frequently ascribed to the hydrothermal agency."

I may be permitted to state that, in the years 1845 to 1848, when a student at the Royal School of Mines, Clausthal, Hannover, Germany, I studied under several eminent professors of geology, and at that time no less than five or more theories—including what is now termed hydrothermal—were known, recognised, and applied practically. Since then I have been, and am still, an ardent student of mining geology in several countries, so that it is not likely that I am ignorant of so important a portion of that science.

When I held, in 1875 to 1877 inclusive, the position as Lecturer at the Bendigo (Victoria) School of Mines, of "Geology as applied to Mining," Mineralogy; also Practical Mining, the Administrative Council of that institution arranged during each winter for a series of public lectures on Popular Science, and at such I elaborated a series of lectures upon the hydrothermal origin of the famous Bendigo Quartz Reefs, without controversy. It appears that at those lectures, —illustrated by models, diagrams, geological specimens, and analysis,—visitors from England, New Zealand, and America attended, and as one result of the interest they must have taken in the subject dealt with, I was subsequently elected, upon unsolicited nominations and recommendations, as a Fellow of the Geological Society of London, which honourable position I still hold and treasure.