the dams were all filled in the space of thirty hours, when it began again pouring into the sea. The weir at Botany is 101 inches in width, and the depth of water now passing over it is five inches. In conclusion, I would observe that I have, I think, shewn beyond a doubt that the water which falls upon the Botany catchment, if properly conserved, is capable of supplying Sydney, and the whole of the suburbs with a minimum quantity of twelve millions of gallons per diem for any number of years to come; that it will suffice until the present population (taking it at 120,000) increases to 480,000; and that the recommendation of the Water Commission to abandon it is absurd. At the same time, I would recommend that no means should be left untried of determining on the best source from which an auxiliary supply may be had, so that when required it may be brought into operation. I would therefore strongly urge that the Botany watershed should never be abandoned as the main source of the supply to these municipalities; that no trespass should be allowed on the watershed which can in any way decrease the quantity or affect the purity of its water, which stands unrivalled for its excellence.


[Read before the Society, Nov. 2nd, 1870.]

In a paper on the "Formation of mineral veins, and the deposit of metallic ores and metals in them," published in "The Transactions of the Royal Society of Victoria, for 1867," the writer discussed the different views advanced to explain these phenomena, and pointed out what appeared to be the only theory which would account for the facts observed.

It is now proposed to lay before the Royal Society of New South Wales a short description of auriferous slate and granite bands of rock occurring in this colony, and as the conditions under which the gold is found in situ in the slate and granite appear to strongly support the views previously advanced, it will be necessary to restate the conclusions then arrived at.
Mineral veins have generally been described as open fissures formed by some disruptive force, and either filled at the time they were opened with minerals in a molten or pasty state forced up from below, or else with minerals held in solution by the water circulating in the open fissures, and slowly deposited on the walls until the fissure was thus gradually closed up. Under this theory the relative age of mineral veins was calculated from the dislocations which occur at their intersections with each other, and Lyell speaks of veins being classed in series on this basis alone.

The paper referred to pointed out that mineral veins were generally formed either on the cleavage, divisional, or sedimentary planes of the rocks they traversed, and not on irregular fissures: and that when the faultings, or throws commonly seen at the intersection of veins, were carefully studied, it would be found that the conclusions as to relative age would in most instances have to be reversed, or else abandoned, on the ground that they would only fix the relative age of the joints on which the veins had formed, and not that of the veins.

As to the filling of the veins; the fact, that the quartz of our auriferous veins has the specific gravity of aqueous-formed quartz, and that numerous veins occur in such a form, and under such conditions as would render it impossible for their contents to have been forced into them from below, appears to dispose of this hypothesis.

For the vein-minerals to have been deposited from the water circulating through the fissures, it is necessary for the latter to have remained open. Now mineral veins are found at all inclinations—from a vertical to a horizontal position—and every miner is aware how difficult it is to keep even a small area of the vein open until the ore is taken out; and that for the veins to have remained as open fissures for the long period of time that would be required to deposit their present contents is an impossibility. Neither will this explanation account for the small detached leads, and bunches of quartz, so common in the schistose rocks. Nor for the veins which cut out a short distance from the surface, where the extent of ground opened is not sufficient to allow of a current of water conveying the minerals, unless the latter were derived from the adjoining strata.

The theory which appears best to accord with the phenomena observed is, that the contents of the mineral veins have been segregated from the rocks bounding the veins, and collected atom by atom on particular lines or joints of the rock, so as gradually to replace the material previously existing there. After being thus formed, many changes might occur in the
large continuous veins which act as water channels in the rocks they traverse, and either through the agency of the water, or some other means, portions of the contents of veins have been removed, and replaced by some other mineral. Bischof mentions one case where the original deposit of a vein had been entirely removed—the sole trace of it left being the pseudomorphic crystallisation of the mineral by which it was replaced.

The changes occurring in the structure of rocks, known as metamorphism, is a deeply interesting subject, whose study has been too long neglected. But since the field work of the geological surveys, now carried out, has shown that the diorite, gneiss, and granite, instead of being intrusive, are only metamorphic rocks, the importance of this branch of geology has been generally recognised, and we may hope that a few years' work will add considerably to our knowledge of the subject. We can now see what powerful agents are at work, however obscure their mode of working may yet appear. In the older Silurians the rocks are laminated by the cleavage forces, and traversed by divisional planes, quite irrespective of the old planes of deposit, while the constituents of the rock have been aggregated by new lines of force, forming bands of slate and sandstone and quartz, which traverse the sedimentary planes, and in many cases have entirely obliterated them. The pseudomorphic crystals afford a good illustration on a small scale of what may be called aggregative force. On these the original mineral has been replaced by a new one, atom by atom, although it is a mystery to our finite senses, how the atoms of matter could find their way through an apparently solid body, to and from the interior of the crystal. Change in the structure of rocks is constantly at work,—consolidation and decomposition, alteration of crystalline character and of chemical forms, aggregation into bands and nodules, and the great agent to which is due the phenomena of cleavage and divisional planes, whose action can be seen in every direction, but whose real character can as yet only be guessed at.

When forces producing such great changes in the rocks are known to be in constant operation, it is surprising that they were not first looked to for an explanation of the growth of mineral veins, seeing that they readily account for most, and are not inconsistent with any of the facts observed.

Various theories have been propounded to explain the mode in which the metals and ores have been deposited in the veins—some holding that they have come from a great depth, either in a molten form or else in a state of sublimation, others that they have been brought in solution in the water circulating through the veins.
As to the former theory, it is considered that to reach the parts of the vein where the metals or ores now are, the minerals must pass through a layer of cold water some hundreds of feet in thickness, in which the molten or sublimed metal must at once have become solid, this view will have to be abandoned as impracticable.

As to the latter theory, there is not the same impossibility of its being correct, in the case of continuous veins, penetrating to an unknown depth. But it will not account for the deposition of metals in the detached shallow veins, or for the bunches of ores in rocks, or in flat veins, or nodules of ore in the solid limestone rocks, or for the cases where the veins traverse a series of distinct beds of rock, and are invariably rich or barren in accordance with the character of the rock bounding the vein.

The theory deriving the metalliferous deposits in veins from the rocks bounding those veins appears to be the only satisfactory explanation of the phenomena recorded, for it meets all cases yet known. In support of this view we might refer to the interesting experiments of Becquerel and Fox, and to the repetition of the experiments of the latter by Mr. Hunt, of the School of Mines, London—to the peculiarities attending the deposit of lead ore in the carboniferous limestones of Derbyshire and the North of England, and to the late deposits of ore found in old mining works.

This, however, only refers to the first segregation of the metals from the bounding rocks, as opposed to their derivation from some great deposit in the interior of our globe—after aggregation the ores may in many cases have been re-arranged in the veins, and where currents of water exist in veins, they may have had some part in effecting this re-arrangement, although the cases where this is possible are not numerous. A similar operation is still going on in the watered alluvial drifts, where gold is being deposited, along with sulphuret of iron (iron pyrites), on organic matter (such as old timber) undergoing decomposition.

The two instances of gold aggregated in bands of rock now brought under the notice of the Royal Society clearly support the above views.

The first case is the slate vein of Cowabee, on the Murrumbidgee River, which can hardly be distinguished from the bounding rocks; the latter consisting of Lower Silurian sandy slates. It is a simple band of slate, nearly vertical, and striking, with the cleavage, nearly north. At the surface the band is fourteen feet wide, and at sixty feet deep it is from sixteen to eighteen feet wide. When closely examined, there is a slightly more mineral look in this band than there is in the
adjoining rock; but the difference is so trifling that it would easily pass unnoted unless attention were drawn to it. The gold is deposited in fine flakes, like gilding on the faces of the cleavage planes, where it has evidently been aggregated in its present form, and not in conjunction with pyrites: neither is there any sign of the latter ore having been collected in the band in such quantities as to affect the gold deposit.

In this close schistose rock there could be no currents of water to carry the gold about in solution, neither is there any passage through which it could have been forced up from some unknown deep region. The sole explanation which could be upheld is that it was formed by aggregation on the line of the band, and derived from the adjoining rocks.

Instances have been previously met with where the quartz usually filling up the space between the walls of a vein had been replaced by auriferous slate of exactly the same character: but this is the first example of a large auriferous band of slate which has been brought under general notice.

The second case is a similar deposit of gold in granite bands at Major's Creek, near Braidwood, but differing somewhat in character. This district has a granite formation, traversed by bands of hard crystalline schist, with every intermediate shade of difference between this rock and the granite.

The alluvial gold is of the fine flaky character always marking gold derived from the granite, but is accompanied by titani-ferous iron instead of by stream tin.

At Major's Creek several auriferous bands of granite have been discovered, and some are at present worked to profit.

Generally, the bands are more or less decomposed; but in one face, where the band was thirty feet wide, it had undergone little change, and was only distinguishable from the bounding rock by its colour, changed through the decomposition of pyrites. These bands are nearly vertical, with a westerly bearing; and have yielded from a trace up to one or two ounces of gold per ton. The gold is of the same fine description as that taken from the alluvial ground, and has originally been pyritous gold. The rock is studded with cavities, retaining the form of the crystals of pyrites, but now filled with brown oxide of iron, and the gold liberated by the decomposition of the iron ore.

At two points where the bands could be seen below the water level, the pyrites was unchanged, and in such quantities as to form a large percentage of the rock. Here the gold will, no doubt, be enveloped in the pyrites, and a rough assay made of the latter gave over an ounce of gold per ton.
In the above case, we have an aggregation of gold and sulphurets of iron on bands of rock,—these bands having, no doubt, undergone partial decomposition at certain points; but still they are distinct bands of rock, not segregated from the granite, or injected into fissures in that rock, but a portion of it, something quite distinct from a mineral vein.

There is the same difficulty in accounting for this deposit of gold and iron ore that is felt in the case of the auriferous slate bands, unless it is referred to segregations from the bounding rocks. It, however, brings out in a more striking light the action of the force which, causing change and decomposition in a homogeneous mass of rock, on lines running parallel to each other over a large area, at the same time has aggregated on the lines thus formed the gold and iron ore previously scattered throughout the whole mass of rock. Auriferous granite bands are stated to exist in South America; but this is the first example of the kind known to me to occur in Australia.

The endeavours made to bring science to bear on practical mining have not hitherto been attended with much success, mainly because the views promulgated were formed in the closet by persons imperfectly acquainted with the facts. If real progress has to be made, the first step must be the careful collection and registration of the phenomena observed, and as these accumulate, the deductions drawn will be tested with greater certainty. At present we must, in a great measure, depend on empirical knowledge in mining affairs, using the hints obtained from scientific inquiry as aids, rather than as guides. The rough outline given in this paper indicates how much has yet to be investigated and explained; and it may take many years of combined labour before the subject is so thoroughly understood as to allow of its application to practical work; but that this will in the end be attained, we may rest assured.

Note.—The Rev. W. B. Clarke, in his "Reports on the Southern Gold-fields," calls attention (at page 58) to the existence of gold in granite, and explains how it has been held enclosed in sulphuret of iron, and liberated by the decomposition of the iron ore. The bands of auriferous granite now opened entirely confirm these views, with the exception that instead of the deposit being confined to the outer surface of the granite it is in vertical bands of rock, on which the auriferous pyrites has been aggregated. In the same district, however, there are large masses of granite rock impregnated with pyrites (far more sparingly than in the bands,) in which the oxidation of the sulphurets, and the consequent liberation of the contained gold, is continually going on near the surface of the rock.
Even allowing no greater percentages of pyrites than I saw in large masses of granite at Major's Creek,—the rich deposits of alluvial gold found in the Araluen valley are not more than might be expected to accumulate, from the denudation of the rock, in the wearing out of this large basin. In the Araluen alluvial claims, small patches of granite traversed by detached leads of gold-bearing quartz occur, and this accounts for the few particles of coarser gold found mixed with the fine granite gold obtained from the alluvial claims. At Major's Creek, small quartz veins, generally yielding pyritous gold, are also found traversing the granite rocks, having the same general bearing as the granite bands above described.

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