

monide of silver and free gold. The telluride is irregularly disseminated throughout the stone in the massive state and also in fine granules. In colour it is steel-grey, with metallic lustre, and it is readily crushed. It is always accompanied by magnetite in fine grains, and sometimes by ilmenite.

Anticipating that it would be found in other portions of the district, I have examined a large number of the richer portions of the lodes, with the result of finding it in combination with the silver in the Crown, Woodstock (Maria Reef), and Ivanhoe Mines, at Karangahape; in the Champion and Lord Nelson Mines, at Te Aroha; and as a trace only in the Rosemont Mine, at Waihi. That this metal is present in much larger quantities than is generally anticipated I feel convinced, and when proper examination of the ores is made before treatment we shall find a great deal more consideration given to the presence of tellurium than has hitherto been the case. Experience already gained elsewhere has shown this metal to be very inimical to the saving of gold or silver combined with it; and, as I have found it present in some of the Crown ore to the extent of 4.18 per cent. it will be seen that it is a factor which will require to be considered when an economical and satisfactory mode of saving the riches of our lodes is adopted.

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ART. XLV.—*On the Preparation of Artificial Chromes for Ornamental Purposes.*

By WILLIAM SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 22nd August, 1888.*]

THE great beauty of some of our native mineral chromes has no doubt incited others besides myself to attempt their imitation, but, so far as I know, no process for accomplishing this has yet been discovered.

In 1870 I found that in the case of chalcopyrite a very beautiful iridescence was induced upon it, in parts, by making it the negative end of an electric battery;\* but there was not that thoroughness or certainty in the process necessary to give it an economic value. However, I still kept in my mind the idea of imitating nature, and at different times made experiments with that object, but until quite recently my efforts have not been attended with much success.

It is well known that the fine play of colours displayed

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\* "Trans. N.Z. Inst.," vol. iii., p. 223.

by native iridescent minerals is caused by the action of thin films of matter upon light—in fact, by what is termed *interference*. In order, therefore, to beautify with colour where nature had stopped at form, it was necessary to find an insoluble substance, unaffected by either air or moisture, but at the same time transparent, and capable of attaching itself firmly in smooth coherent films on those minerals which are the best reflectors of light.

It gives me great pleasure to inform you that my efforts in this direction have been completely successful, as may be seen by an inspection of the exhibits on the table. I shall now proceed to place before you the results of my investigations.

While experimenting with hyposulphite of copper for another purpose, I observed that a portion of the cupric sulphide which I had precipitated therefrom by heat had attached itself in a continuous transparent film to the vessel containing the solution. The idea of utilising such films for chromatic purposes at once suggested itself, and I accordingly plunged various fragments of metallic sulphides into the boiling solution of cupric hyposulphites, and was gratified to find that in a few minutes they had all become enfilmed to such an extent as to appear in the sunlight of a ruby-red colour. I also found that by longer immersion all the colours of the spectrum could be obtained.

The films producing these colours, even while wet, were found to adhere to the sulphides so tenaciously as not to be removed without the aid of solvents. To test the cohesion of the film as applied to galena, I gummed a piece of paper on to it, dried it thoroughly, and then tore it off forcibly, without the least injury to the film. In the case of stibnite similarly treated, much of the film came off with the paper. On this account I am inclined to think that the surfaces of the galena had chemically united with the inner surface of the cupreous film, thus forming a compound sulphide.

To produce the very best effects with these films it is necessary to operate upon the fresh surfaces of opaque crystals, as these are the most highly reflective of any mineral surface that we know of. So far as I have yet pushed my experiments, the best minerals to use for this purpose are arseno-sulphide of nickel, mispickel, galena, and stibnite.

Specimens of the last two, both in their natural and artificially-coloured states, are on the table. The more lustrous of our cokes also take on a very brilliant green.

After repeated experiments for other substances capable of forming adherent films on glass or native minerals, I find that the following do so as precipitated from alkaline hyposulphites: sulpho-arsenide of silver, sulpho-arsenide of copper,

and sulpho-arsenide of cobalt. All these, however, are of too dark a colour to permit of their use for ornamental purposes.

The best way to obtain cupric-sulphide films upon minerals is as follows: One pound of hyposulphite of soda is dissolved in two pints of water, and then mixed with an aqueous solution of commercial sulphate of copper, consisting of 1oz. of the salt to eight parts of water. A little more or less of either salt may not matter much, but what is absolutely necessary is to have a large excess of the hyposulphite, which is known by the thorough discolourization of the cupric compound. If too little is used a brown film of cupreous sulphide forms, which is not sufficiently transparent for the object in view.

The mineral to be treated is attached to a piece of string and plunged into about ten times its bulk of the mixed solution, to which heat is then applied. Just as it begins to boil the liquid turns green, and cupric sulphide is precipitated, principally as a black incoherent powder; a small proportion, however, attaches itself to the mineral and to the sides of the containing vessel. About half a minute after the solution begins to boil the mineral should be lifted out for examination. The first colour to show is, in the case of galena, a ruby-red; then, in turn, as the immersion is prolonged, yellow, emerald, green, blue, black-blue, and so on, in the reverse order of the spectrum as usually stated.

Should the mineral, by *too long immersion*, pass beyond the desired colour, an aqueous solution of ammonia will restore the requisite hue by reducing the thickness of the film; whilst, should it be necessary to remove the film altogether, a strong solution of cold cyanide of potassium will accomplish this at once and leave the specimen itself quite uninjured, this salt having little effect on the common sulphides.

So far I have dealt only with opaque minerals. In the case of transparent objects it was necessary to find an opaque and lustrous substance capable of being deposited in the same manner as cupric sulphide, and upon whose outer surfaces a film of cupric sulphide could be deposited with the same effect as when these massive sulphides were used.

After several experiments I was successful in finding this reflecting background—namely, sulphide of nickel, which can be precipitated in thin films from its hyposulphite solution. Two operations are therefore necessary to coat transparent objects such as glass with iridescent cupric sulphide. They must be first enfilmed with sulphide of nickel, as precipitated from its hyposulphite, and afterwards coated with the cupric sulphide by the process already described.

It only remains for me now to inform you what I consider the exact nature of the films which, by their action on light, afford the very beautiful colours of the specimens in the jars before you.

These films are pure protosulphide of copper, and are therefore of precisely the same chemical nature as the mineral covelline.

In chemical and mineralogical works covelline is described as an opaque mineral. This is no doubt true as regards its massive form; but, as it appears of a purplish colour by reflected light, it should certainly show the complementary colour to this—namely, green—when viewed in thin sections by transmitted light. An inspection of the thickest of the films on the glass slides will prove that, like covelline, they reflect a purple or purplish-blue colour.

That the nature of the films is as I have asserted, is capable of further demonstration by the aid of the electrical instruments on the table. Both the films and the covelline, when connected with the poles of the small battery, allow an electric current to pass along them, as can be seen by the vigorous movement of the galvanometer. That cupric-sulphide films are fairly good conductors of electricity is shown by the fact that even the thinnest red-coloured films, when deposited on stibnite, which is itself a non-conductor, conduct the current, and they do this without being at all disrupted or heaved into corrugations, contrary to what I found in 1860 to be the case with films of silver deposited upon glass by organic matters from argentic salts, when subjected to a similar test.

These artificially-produced films are also of the same nature as those on bornite and peacock copper ore. These natural films are likewise conductors of electricity, and, like those deposited on glass slides and galena, are quickly removed by cyanide of potassium, the resulting solution containing copper and sulpho-cyanogen.

Before these investigations, I had the opinion, in common with many others, that these natural films were metallic oxides; but the electric battery applied to them at once disabused me of this erroneous belief, and led me to the application of the cyanide test, by which their real nature was quickly demonstrated.

The beautiful iridescence, then, which nature has given to certain of the copper ores is clearly due to films which are of the same character as those deposited on the exhibits now before you: but the processes by which each is accomplished are very different—that of nature being by the simple oxidation and removal of the sulphide of iron from the compound sulphide, leaving the cupric sulphide behind; that of man by the

deposition of the metallic sulphide from its hyposulphite solution. Still, the material is the same in each case, and I doubt not but that, as deposited upon the comparatively fixed minerals, the artificially-produced film will prove to be quite as durable under ordinary atmospheric conditions as those which nature has so laboriously and sparingly deposited:

In conclusion, I would draw your attention to the artificially-prepared chromes on the table, and to the glass slides, on which, at the suggestion of Mr. McKay, I have spread a quantity of the covellite-coated galena sand, in order to show the adaptability of these chromes for ornamenting picture-frames.

ART. XLVI.—*On the Fallacy of the Electro-capillary Theory.*

By WILLIAM SKEY, Analyst to the Geological Survey.

[Read before the Wellington Philosophical Society, 3rd October, 1888.]

Two theories have been advanced by scientists to explain the action which takes place when aqueous solutions of potassium sulphide and cupric sulphate come in contact with each other in Becquerel's electro-capillary cell.

Becquerel, who originally discovered this phenomenon; and who by its means afterwards produced, or, rather, imitated, a large number of natural minerals, supposed it to be due to a combination of a physical force with that of electricity, to which he applied the term "electro-capillary action." Speaking of the deposition of the copper, he says, "The two liquids, acting on one another through the capillary space, form a galvanic couple, the circuit being completed in the first instance by certain parts of the walls of that space, and afterwards by the separate metallic particles. The correctness of this view may be shown by dipping the ends of a bent copper wire into the tube-apparatus above described, so as to form an ordinary galvanic circuit of two liquids and a metal. The end of the wire dipping into the alkaline solution is then attacked, and forms the positive pole, while that which dips into the copper solution forms the negative pole, and becomes covered with metallic copper; at the same time thiosulphate and nitrate of sodium are formed, and the copper nitrate is decomposed; but no trace of metallic copper is formed, either on the crack or on the adjacent portions of the tube. As soon, however, as the wire is removed, the crack and the inner surface of the tube become covered with metallic copper. This shows