Placer Gold, Experiments With California Gold;

The following interesting paper was read at the last meeting of the San Francisco Microscopical Society by Henry G. Hanks, State Mineralogist

Some years ago, I read a paper before this society on "Rusty Gold," giving the result of my experiments and observations up to that time. I have since continued the study of placer gold in this abnormal condition, which has led to the discovery of important facts, bearing on the production of gold in California, and, as these discoveries must, to a great extent, have remained unknown were it not for the microscope, I consider this society the proper medium through which to make them public.

For many months I have conducted a series of experiments in my private laboratory on placer gold from numerous localities in the State. I have also studied the behavior of gold in the presence of mercury under all conditions I could think of, the results of which have been carefully recorded and preserved for publication, the most important of which may be summed up as follows:

Gold and Quicksilver.

When perfectly clean gold is exposed to the action of pure quicksilver it is instantly seized by the latter and coated with amalgam. The accident of gold being alloyed with other metals in nature does not impair its affinity for mercury, if the surface is made bright mechanically by filing or scraping. , Much of the native gold found in placer mines, apparently clean, is slightly tarnished by the oxidizing or mineralizing of its alloy, in which case it amalgamates with difficulty. I have failed in every instance to find gold in quartz in this condition, although intelligent miners have informed me that they have sometimes observed it in their experience. A large proportion of the placer gold found in California is wholly or partly coated with silica, cemented by eesquioxide of iron, as stated in my former paper. When wholly coated it is perfectly inert to the action of mercury (one might as well put gold in a glass bottle and attempt to amalgamate it from the outside). When partly coated, the exposed parts become amalgamated, and to that extent only 1b the gold held by the mercury. If rusty gold is digested in hydrochloric acid the iron is dissolved, and a slight mechanical force then serves to detach the silica, when amalgamation takes place without difficulty. There is no hope of being able to free the gold from this coating during the few hours it is exposed to the forces employed in the well-known hydraulic process. When clean gold amalgamates it does not become homogeneous, but the amalgam forms only on the surface. I have had a piece of placer gold in mercury, standing in my laboratory, for several months, during which time I have frequently triturated it—sometimes several times a day—and it is not yet dissolved; still, in pouring from one vessel to another, the mercury flows freely without showing the gold, but I can at any time fish it up with my finger. Gold, so amalgamated, could not, in the process of placer washing, escape from the mercury, but coated gold, under the same circumstances, will float on the surface of the quicksilver, and any slight force sufficient to overcome its specific gravity will detach it.

Artificial Imitation of Coated Gold.

The coating of gold may be imitated, as found by experiment. A piece of pure gold, after annealing, was placed in pure mercury, and it instantly became amalgamated. Another portion, exactly similar, was hammered on a perfectly clean and polished anvil, with a polished hammer, and placed in mercury like the first. It became as quickly amalgamated. Pure quartz was then ground to a powder and sifted on the anvil in a thin stratum. A third piece of the same gold was then laid on the powdered quartz, struck several times with the hammer, turned over, placed on a different spot, and again hammered. The gold was then examined under the microscope, and seen to resemble the coated gold found in the placers, the quartz particles being imbedded in its surface. When placed in mercury, and allowed to remain for some time with frequent agitation, it floated on the surface, and seemed to be wholly unacted upon, but when placed under the microscope it was found that the mercury had attacked the gold through the small interstices, but only to a very limited extent. The gold was then placed on an iron slab, and gently rubbed with an iron muller, by which treatment it became more perfectly coated, and was now an exact imitation of the natural coated gold, minus the iron cement. In the natural coating of placer gold I consider the cementing to be a secondary process, and the sesquioxide of iron to result from the decomposing pyrite, which was abundant in the quartz veins that yielded the gold.

Genesis of Auriferous Gravels

I have reason to believe that we have been generally mistaken as to the genesis of the auriferous gravels in the beds of the ancient rivers; for river beds they are, without a reasonable doubt. But the theory that these immense bodies of gravel were deposited by a great flood, by a series of floods, or by long deposition by the rivers themselves, does not account for the gold in them. The microscope seems to show that they are not river Band at all and have never been far removed from the place that gave them birth. I have examined samples from many localities, including some of the most noted hydraulic mines in the State and the result is invariably the same. The sand grains are all sharp and angular, and not at all worn as are those from the sea-shore, the great Colorado desert, the agricultural soils, and the beds of the present rivers. To verify these results, I pulverized quartz on an iron slab to different degrees of fineness, and examined it under the microscope, finding it identical with the sands from the gravels of the gold placers.

Ancient Riverbeds.

That the beds of the auriferous gravels are channels of ancient rivers seems to be proved by an examination of the surfaces exposed in the hydraulic mines, in which may be seen deep pot holes worn by bowlders kept in violent and long-continued motion, the little deposits of magnetic sands under the lea of protecting bowlders, marks of eddies, and by the fact that all flat bowlders on the bottom overlap like shingles on a house-top, the small ends being invariably down stream. That the channels were filled by the rivers themselves seems to be as clearly disproved by the fact that gold is distributed throughout the whole mass, from bedrock to surface, by the sharp angular sands, and by the coated gold. Water must have flowed in the ancient rivers comparatively free from obstruction for a long period before the deposition of the gravels to admit of the deep pot holes being worn in the hard rocks. From the examination of the hydraulic sands, it is fair to infer that the same force that crushed the rocks set the gold free, flattened the grains and coated those which passed between the rocks and the grinding force, in a manner similar to that pursued in my experiment mentioned before.

Material Moved in Hydraulic Mining'.

To convey an idea of the enormous quantity of matter moved in hydraulic mining, calculations have been made from published data, in which the gravel moved is compared with the gold produced. At the« Sailors' Union mine, Iowa Hill ridge, 1.615577 parts, by weight, were washed away to obtain one part of gold. At the North Bloomfield, in Nevada county, the removal of 12.107116 parts of gravel was required to yield one part of gold. A mechanica1 analysis of hydraulic gravels was made from the well known hydraulic mines, from which it would appear that a large portion of troublesome mining debris might be diverted from the river beds, where the contour of the country will admit, and spread harmlessly on some hillside, or deposited in a canyon, where it could do no damage. A sample from a pillar in the Nevada mine chalk bluffs, Nevada county, contains:

Large pebbles ,	39.80%
Smaller	29 80%
Total	69.60%

The remaining 30.40% would all pass through a grizzley, the bars of which were one inch apart. If the large bowlders in the mine could be calculated, it would greatly increase the percentage of coarse material. A sample of gravel from the Polar Star mine at Dutch Flat, Placer county, gave 40% of coarse matter, but as it is well known that the majority of the filling in the channel at this mine is large bowlders, this analysis is only interesting as showing that 40% of the comparatively fine gravel is coarse enough to be separated by properly-constructed gratings.

Washing with Pan.

To show the relation between hydraulic mining and pan washing, I submit an analysis of the latter which is perfection itself for saving gold, although hydraulic mining claims to be the same on a gigantic scale. The skillful miner, in washing a panful of dirt, unconsciously divides the operation into five stages: First, he allows a certain quantity of water to flow over the rim of the pan as he holds it in a convenient stream or prospecting trough. He breaks the lumps with his fingers and stirs the contents of the pan until a soft mud is formed, Sinking, now, the pan beneath the water, the second stage commences. This is to so agitate the muddy prospect that gold, gravel and coarse sand sink to the bottom, while the finer and lighter particles flow over the rim and escape. This being for a time continued, the remaining contents of the pan become clean and the water is no longer loaded with slickens. The third operation is to pick out carefully all the large pebbles and gravel which are examined, and, if found worthless, are thrown aside. The agitation is continued with but little water in the pan, and by a motion of the ball of the thumb, difficult to describe, the coarse particles are raked out and rejected. At this stage a very large proportion of the original prospect has been removed, but every grain of gold lies at the bottom, although still invisible. The fourth operation is to so agitate the remaining contents of the pan (now inclined and only partly under the water) that the coarse sand flows over the edge in a thin stream, every particle passing under the eye of the operator, who maybe certain that no gold escapes. This is continued until but a small quantity remains in the pan, when, lifting it from the water, the last operation begins, which is the concentration and perfect separation of the gold. This is effected by an undulatory motion, causing the sand to flow with the water across the bottom of the pan, revealing a cluster of gold particles, if the dirt is rich, and wholly isolated. The pan is then inclined toward the sand, leaving the gold stranded in one portion, and the sand and water lying in another. The edge containing the sand is then held over and very near the water, of which the miner lifts a small quantity in the hollow of his hand, and, pouring it behind the sand, washes it away, leaving the gold only in the pan, There being no quicksilver used, the gold is collected wholly by its specific gravity, and rusty or coated gold particles would be found with the other gold, although It might be mistaken for something else, and thrown out as worthless, by an inexperienced prospector.

Imperfect State of Hydraulic Mining

. After a careful study of this most interesting and important subject, I cannot evade the conclusion that hydraulic mining, not withstanding its wonderful advancement, is still in an imperfect state. I am convinced that more gold is lost than is generally known, or miners are willing to admit. This being granted, a remedy should be sought, and as theory is not always confirmed by practice, experiments on a moderate scale should be made, based on the experience of miners, who are aware of the loss, but helpless to prevent it.

Modified Methods of Separation Suggested.

It is my opinion that the methods now employed should be materially modified. As far as the disintegration of the gravels is concerned, nothing could be better, but the very force used in this operation defeats the object if carried too far. I consider it a foregone conclusion that coated gold cannot be saved by the use of quicksilver alone, and that it, with much of the tine gold, is carried forward by the great force of the water it the sluices and lost in the dump. This force, necessary to wash down the gravel banks, is not desirable in the sluices; on the contrary, it is highly detrimental, if the great mass of the worthless material can be got rid of at an earl; stage of the operation, as practiced on a small scale in pan washing. It is only to carry this debris through the sluices that this powerful current of water is required.

A Suggestion.

It is easy to find fault with the working of any process in use, but not so easy to propose a remedy. What I am about to suggest is purely theoretical, and may not work in practice, but it is worthy of the consideration of miners. The "grizzley" is a grating of iron bars now used in nearly all hydraulic mines of the State, to sift out—on a large scale—the bowlders present in the flowing debris, and it is a recognized principle to do this as early as possible. The debris freed from the larger bowlders passes through the sluices more feely, after which it is caused to flow over the pavements find dropped on the bedrock. But there is a point beyond which this treatment should cease. The proper point being decided upon, a set of grizzlies should be introduced, diminishing in fineness until the last one is no wider between the bars than twice or thrice the width of the largest particles of gold found in the mine as learned by experience. What remains on the grizzlies should be conveyed to the dump by a special channel, using a large portion of the available water for that purpose, or, when possible, shot off into some lateral canyon or depression. To divide the water, and at the same time to allow a portion to pass through with the fine gravel and sands, the bars of the last grizzley should be laid at right angles with the current and given the proper grade, which can only be learned by experience. What passes the last grizzley should be conveyed—using the remainder of the water —through sluices, as at present, but with less grade, and so constructed that a considerable portion of the heavier matters should remain in them, including the gold, arrested by properly constructed riffles. From this point it might be necessary to have double sluices, one to be used while the other is being cleaned up. At proper periods, as determined by experience, the accumulations should be removed and concentrated, using either of the well-known concentrators for that purpose. Rusty gold would thus be saved by its specific gravity, which is know to escape the quicksilver, while fine gold, moving more slowly in the less inclined sluice beds, would find its way to the bottom and be saved. This is attempted now, in the undercurrents, but the fault with them is that there is too little space provided for the accumulation of the heavier parts of the material washed, and the absence of the secondary concentration.

Small bowlders are now rushed through the whole length of the sluices, and dumped into the rivers, miles away. It is absurd to suppose that gold should not be carried forward with ' this rush of water, and specially so after the interstices between the pavement blocks are filled.

At the American mine, Nevada county, there are 20 undercurrents, and gold is saved on the last one. Is it supposable that another would not also save a portion of the precious metal? It is a well-known fact that diamonds exist in the gravels of some of the deep placers, and it may be assumed that they are also in others, not now known. Yet it seldom occurs that one is found, which 1 consider another proof that too great a force of water is employed in the sluices below the bedrock tunnels.

This proposed improvement is clearly based on the results of my experiments, and it seems to be theoretically correct, but how if, will meet the views of experienced miners, or how it will work in practice, remains to be proved.

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