The Saving of Fine Placer Gold

By Fred H. Hazard*

The problem of saving fine placer gold has not received sufficient attention. Any process whereby black sands may be collected for independent treatment will promote economy.

During recent years, intricate processes have been worked out for saving the most minute portions of the valuable constituents of ore. In fact, the financial success of a lode mine today is frequently attained only by a high percentage of extraction. The same progress has not marked the treatment of placer gravel. Much ingenuity has been shown in devising cheap and effective methods for the mining end of the operation, but progress in the prevention of loss of fine gold in sands and gravels has not been characterized by striking improvements on methods employed in the early days of California.

Contrasting Conditions in Placer and Lode Mining

This is not to be wondered at if one considers that success in lode mining depends mainly on a high saving efficiency of mill or metallurgical treatment, while in placer work it depends, to a greater extent, on economies in mining. The former has to deal more with quality, the latter more with quantity. In the former, the arrangement of the mine is planned to accord with the process of ore treatment that is to follow; in the latter, the process must conform to the conditions of the mine. The former, therefore, is not dependent on local conditions and the process of treatment is not affected thereby, while the latter is dependent wholly on local conditions and these conditions are almost never similar: Character of deposits varies widely; grades and dumps must be regulated in accordance with the local topography; water supply is various and variable. Dredge mining, by which many of these adverse conditions are eliminated, has shown the greatest progress in the saving of fine gold.

In 1905 the U. S. Geological Survey, working at Portland, Ore., took up the problem of separating fine gold and platinum from the so called black sands, which have always been the curse of the placer miner. Much benefit was gained by studying the separation of these metals from black sands, but the Survey did not take up the more important investigation—how to save this black sand concentrate cheaply and effectively in placer practice, to be further treated by the methods worked out at Portland.

The object of this article is not to suggest any method of procedure, but to state a few facts brought to my attention in travels through some of the placer fields of California, Oregon and Alaska, and to describe a plant, the design of which more nearly approaches a solution of the problem than anything else that has yet come under my observation.

A Typical Placer Operation

In most cases, the placer miner faces this condition: He has a deep deposit of earth, sand, gravel and boulders, through which are disseminated practically infinitesimal quantities of gold. To recover this gold the deposit from top to bottom must be treated and, in order to make the undertaking a success, a large amount of material must be handled in the shortest possible time. Water under pressure has made this possible. It has never been found feasible to screen the gravel before it enters the sluice. Therefore, the sluice, besides being the main gold-saving device, must act as a runway for material ranging in size from slimes to heavy boulders. Again, the quantity of water in the sluice is constantly changing, as the nozzles of the giants are pointed to different portions of the bank, and as the caving of the bank sluice.

The sluice, therefore, has to serve too many purposes, under adverse and constantly changing conditions, to expect much improvement in it as a saver of fine gold. It is apparent that only the coarser particles of gold and such of the fine as should happen to come in contact with the quicksilver in the riffles of the sluice will be lodged and thereby saved. As a general rule, it may be stated that the wider the sluice boxes. compatible with the moving of material, and the sharper the grade, within certain limits, the better the results. Both adjustments tend to reduce the eddying motion that keeps fine gold from hugging the bottom and thus coming in contact with the quicksilver. Frequent drops in the string of boxes aid in the breaking up of conglomerated material; likewise the omission of a few sections of sluice in bedrock cuts gives rusty gold a better chance to be brightened, and gold with adhering clay to be freed, by the grinding action between the rock of the cut and the pebbles and boulders passing through it.

Utility of Undercurrents

Such improvement as has been made in the saving of placer gold has come through the use of the undercurrent, which separates the finer material from the main sluice, to be treated independently. Only within the last decade has the undercurrent been extensively applied and wherever it has been tried, and has received consistent and adequate attention, splendid results have been obtained with nearly all of the various gold-saving devices that have been installed in connection with it.

Undercurrents should be placed as near the end of the tail race as possible, for it is advisable to have them pass all of the water not required to force the oversize to the dump. The fines are almost equally distributed from top to bottom of the water as it comes through the tail race, and I believe, as a result of many tests, that the quantity of fines passing over the grizzlies and the quantity passing through bear a direct ratio to the respective quantities of water passing over and passing through. Thus, if one-third of the total quantity of water coming through the sluice fails to find passage through the grizzly bars, one-third of the total fines passes to the dump and is lost. I also believe that this proportion holds good as to the gold values of the fines, as I have panned pieces of rusty gold (some of them worth as much as 10c. apiece) from water dipped not more than 2 in. below the surface of the sluice water, a short distance above the grizzlies.

Two styles of undercurrent grizzlies that have come under my observation possess many advantages over the flat- or round-iron patterns. Both have V-shaped bars. One in use in southern Oregon was cast at a foundry in sections of 1 x 2 ft., four sections occupying the width of the sluice, and extending in length as the season's water supply demanded. If a section became worn or broken it could be replaced without disturbing the remaining sections. The other style, doing splendid work on the lower Klamath river, consisted of V-bars which received a sidewise rocking motion by the passing of water and boulders over them. The hinge effect was obtained by means of inverted U-bolts working loosely in eyes drilled through the thin part of the V-bars; the ends of the bars rested on cross plates to which the bolts were fastened. The V-pattern is a great advantage in the prevention of clogging, and

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the latter form was particularly free from this annoyance.

The general principle of gold-saving devices for treating the fines coming through the grizzlies has been to widen the sluice and increase the grade, thereby spreading the water carrying the fines into as thin a sheet as possible and thus giving the fine gold a better opportunity to come in contact with the quicksilver in the riffles.

The experiments conducted at Portland by the U. S. Geological Survey proved conclusively that wherever a loss of black sand occurs there is bound to be a loss of fine gold, and that to make a high saving of fine gold it is necessary to save the black sand. I believe, therefore, that the solution of the problem will be found in a method by which black sand concentrates may be effectively and economically segregated from the fines and treated as a separate product.

In 1905, a plant planned with this object in view was established at the Old Channel mine in the Galice district of southern Oregon. The accompanying drawing is a plan of the table plant. The following description is not for the purpose of giving the idea that the plant solved the difficulty of saving fine gold to any notable degree, but merely to depict the ideas carried out in this first attempt to save black sands on a large scale ever made at a placer mine, to show wherein the results failed of the object sought and wherein they approached success.

The Old Channel mine is situated on a bench 1000 ft. or more above the present bed of the Rogue river, and about a mile back from it. The banks of the placer pit are from 100 to 300 ft. high and are composed of the general run of placer material: Soil, fine sand, sand and gravel, and boulders of from a few pounds to several tons in weight. At the time I visited the mine, one 5-in. giant was in constant operation under a 510-ft. head of water, and a 4-in. giant utilized any oversupply of water that might at times be available. Probably from 2000 to 2500 cu. yd. of material were being washed to the 4-ft. sluice per 24 hours. The sluice was placed in a bedrock cut, and was somewhat over 1500 ft. long. The grizzly of the undercurrent was situated a few feet from the end of the last box and was passing about three-fifths of the fines, ranging in size from ½ in. down.

Plant for Catching Black Sand

The plant for collecting the black sands and fine gold consisted of 29 cocoa-matting tables, as shown. The product passing the grizzlies was carried by a launder to a distributing box, and an amount regulated by 14 adjustable gates was spread, by means of wooden strips nailed to short launders, over iron plates punched with ¼-in. holes. The oversize from these plates dropped to a sluice box and was carried by gravity to tables Nos. 25 to 29. The undersize from the plates was led by appropriate launders to tables Nos. 1 to 14. Such of the material coming to the distributing box as these tables were unable to treat passed over the end boards of the distributing box—a first portion over the end board on the right (as shown in the plan) in an amount regulated by the hight of the end board, and the remainder, if there should be any, over the end board on the left. The material passing over the end board on the right ran by gravity to tables Nos. 15 to 19 and that over the left end board to tables Nos. 20 to 24. The quantity of material coming through the grizzly varied greatly from one moment to another, and this arrangement automatically furnished a uniform supply of material to the main tables, Nos. 1 to 14.

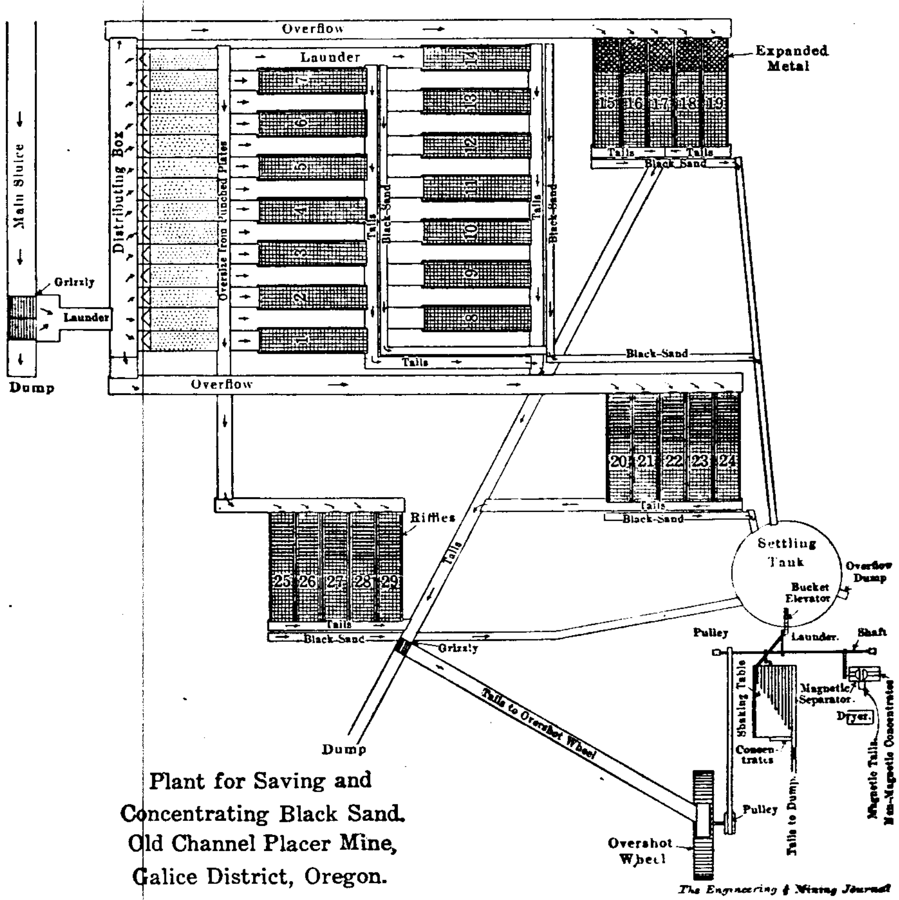
Construction of the Tables

Tables Nos. 1 to 14 were covered with coarse cocoa matting, the upper end of which was inserted under a strip of sheet iron nailed to the floor at the head of the table; the matting was held on the floor of the table by pressing the sides under 2x4-in. pieces running lengthwise of the tables and held in place by cam levers which, when lowered, bound these pieces and the matting firmly to the bottom. By the use of such levers the matting could readily be removed for cleaning and washing. The slopes of the tables were independently adjustable; a drop of 6 to 8 in. was found to give the best results.

The upper portions of tables Nos. 15 to 20 had expanded metal over the matting, and tables Nos. 20 to 29, inclusive, were each about half covered with Hungarian riffles placed over the matting.

The tailings from all the 29 tables were carried by flume from the ends of the respective tables and sent to the dump. A portion was utilized in furnishing power for concentrating tables and electro-magnetic separators, which were used in the cleaning-up process, by passing over an overshot wheel of 16 ft. diameter.

The concentrates from the tables, which were cleaned in rotation, were led to V-shaped troughs by laying a sheet-iron launder under the bottom edge of the table and over the tailings sluice, and thence were washed to a settling tank. The concentrates collected in the settling tank were fed by a small bucket elevator to a shaking screen, the product passing through a screen being led to a Wilfley table. The concentrates of this table were cut so as to include a large portion



Plant for Saving and Concentrating Black Sand. Old Channel Placer Mine, Galice District, Oregon.

of the black sand. This was then dried and passed through an electro-magnetic separator which removed the valueless magnetite, composing about two-thirds of the bulk. The nonmagnetic portion was again sent to the concentrating table and reduced to as small a quantity as compatible with retaining the gold. The heads were then treated in a cleanup or shipped to a smeltery.

Shortcomings of the Black-sand Plant

The two chief faults of the plant were the short period during which the tables were efficient, and the length of time required to clean them. Both were responsible for heavy losses of gold and a high expense of operation. The efficiency of cocoa matting as a concentrator and gold catcher ceases the moment the interstices of the matting become filled with black sand; after that the matting acts as a smooth surface and the heavy sand is washed over with the light. Under ideal conditions of grade and uniform flow of material, this period of efficiency was found to be not over 20 min. It required two men working steadily for 5 hours to make the rounds of the 29 tables. A general superintendent was required to adjust the flow of material on the tables and keep the plant in running order. Use was found for at least one extra man per shift. The labor expense for a 24-hour day was as follows:

Two superintendents, 12-hour shifts at $3..	$ 6
Two laborers, 12-hour shifts at $2.50.......	5
Six table cleaners, 8-hour shifts at $2.50....	15
Total (10 men)........................	$26

Upkeep and incidental expenses would bring the total expenses to at least $30 per day.

Some of the difficulties experienced were as follows: The punched plates, when placed on a grade such as was found necessary to pass the greater bulk of fines, became banked and required constant attention; a greater length of plates on a sharper grade did not remedy the defect. The bottoms of the tables underneath the matting became banked with fine sands, finally making an uneven surface on the matting above, thus causing sands to clog on the raised portions and the flow to run in narrow streams over the matting. On the tables in connection with which punched plates were not used, the coarser material accumulated quickly and banked the fines. A grade to these tables sufficient to overcome this trouble caused poor results as to retaining black sand and gold. A remedy for the former defect could probably be effected by stretching the matting firmly to the bottoms of the tables, and for the latter trouble by screening out the coarser particles before they reached the tables.

While this plant was far from successful in saving a good proportion of the black sands, or doing it economically, it did prove beyond a doubt that black sands do mechanically carry gold, and that the gold recovered was in proportion to the quantity of black sand saved.

Extraction of Precious Metals

The manner of saving the gold and platinum from the collected black sand is a matter of minor importance, and resolves itself into a metallurgical or an ore-dressing problem. The process used at the testing plant of the U. S. Geological Survey, at Portland, Ore., was as follows: Screening to as fine a mesh as would pass all the valuable material profitable to save; concentrating on shaking tables of the Wilfley type, either before or after hydraulic classification (a better concentrating product was obtained with some sands by hydraulic classification but with most sands it was found to be of little aid); drying the concentrate and freeing it of magnetite, which generally composes the major part of black sands, by passing through an electro-magnetic separator having poles of low strength, such as the Dings or Knowles; reconcentrating the nonmagnetic product on tables into as small a bulk as practicable. This rich concentrate was then treated by again passing through an electro-magnetic separator of greater strength, such as the Wetherill, which freed it of minerals such as ilmenite, chromite, garnet, and monazite, the remaining portion being treated in a clean-up pan. If the pan failed to make a high percentage of saving, the material was treated by smelting. The latter method is almost imperative where there is a fair proportion of fine platinum. Sodium amalgam was found to amalgamate platinum, but it also amalgamated nails, black sand, and almost everything with which it came in contact. Also its efficiency as a platinum amalgamator was of a short duration, as the water used in washing soon absorbed the sodium from the quicksilver.

Suggested Design of Black-sand Concentrator

Practice and experiments prove that before treating material for close saving a sizing must be made. I believe that the elimination of oversize by screening on at least a 20-mesh screen is the important feature. In the smaller workings, this might be accomplished by passing the material, as it comes from the grizzly, over perforated plates, and would be wise economy even though it required the services of a laborer to keep them clean. Some mechanical arrangement for bumping these plates underneath could probably be installed in most cases, and operated by some of the power going to waste over the end of the main sluice. In the larger operations, revolving trommels or large shaking screens are essential. By their use the fines would all be saved and the oversize be mechanically disposed of. From this point I believe that hydraulic classification or jigging, or both, should enter largely into the operation. It is yet a matter for experimentation and until some data are obtained it would be unwise for the ordinary placer miner to attempt it.

The screened product should be spread thinly over shallow strips or Hungarian riffles on tables with a slight grade. The riffles should be so installed that they may be easily removed and the tables quickly cleaned at frequent intervals. The tailings from these tables should go to deeper riffles on tables with a sharper grade and quicksilver should be used in conjunction. Before the tailings from the latter tables reach the dump, a profitable saving might be made by passing them through Pierce amalgamators, which have a large capacity and have proved efficient in many instances of placer mining. The advantages in the use of cocoa matting are manifold, and it should be used underneath the riffles on all the tables.

Phœnix United Mines, Ltd.

London Correspondence

This company was organized in 1907 to secure the title of the Phœnix United Tin Mines in Cornwall, in which the Cosmopolitan Proprietary and Hannan's Proprietary companies were also interested. Better progress in unwatering is now being made than formerly, because of the fact that the stopes in the deeper workings are not as large as in the upper levels. At the present time the mines have been drained to a depth of 615 ft. below the adit, and this has been accomplished in a manner which appears to be somewhat novel in the Cornwall mining district. A large shaft was sunk at a safe distance from the old workings, and at a depth of 720 ft. a crosscut was extended from this shaft. From the face of the crosscut and with a diamond drill a hole was drilled, through which communication with the old workings was established. This allowed the water to flow to the new shaft and from here it was pumped to surface with an 80-in. Cornish pump, the latter now having been at work for over 16 weeks. It is now believed that a second diamond-drill hole is necessary in order to drain the water to the 720-ft. level.

There is some question as to the economy in this method of "forking" a mine, and it is believed that it is the first time that such a method has been employed in Cornwall. The work at the crushing and milling departments is nearing completion. The prospectus of this company estimated that 150,000 tons of tin ore annually would be milled.