California Drift Mining, 1899, Written for the Mining and Scientific Press.

Drift mining originated in California and has reached its present magnitude largely as an outcome of the inhibition of hydraulic mining. At first an experiment, it proved successful, and rapidly developed into a great industry. It is in some respects unlike other mining, though the general principles are essentially the same as those in other mines. It consists of removing the richer gold-bearing gravel lying in the channels of the ancient rivers from the bedrock without disturbing the overlying low-grade gravel and volcanic material, which is sometimes hundreds of feet in thickness. By the hydraulic method, these deep deposits of gravel, sand and lava were washed down by the powerful streams from the monitors and the material carried into the flumes by the large volume of water employed. Some of the largest and most remunerative hydraulic mines had banks several hundred feet in height, from which the volcanic cap had been previously removed by erosion, and all of the remaining material—the detritus accumulated at the bottom of the ancient river—was gold-bearing and easily washed down. The greater number of channels, however, were covered under hundreds of feet of volcanic mud, tufa and brecciated lava fragments, and some of them by massive flows of basalt and andesite. These could not be economically hydraulicked, and drift mining had already made considerable progress before the courts enjoined the hydraulic miners, compelling them either to cease operations altogether or to resort to the drift method.

Most of these ancient river beds lie flat, or nearly so, having a normal grade the same as modern streams, though in some localities—as about Murphys and Vallecito, in Calaveras county—the channels are tilted and faulted by the movements of the earth's crust, indicating that dynamic disturbances have occurred there within comparatively recent time.

The gold-bearing channels are reached through tunnels driven directly in on the channel, or through a crosscut tunnel extending through the bedrock into the rim or underneath the channel; or else a shaft is sunk through the lava cap and upper layers of gravel to bedrock and the channel worked from the station at the foot of the shaft.

A long, main gangway is run up the channel, from which the gravel is breasted out on either side, the roof being usually supported by a system of posts and breasting caps. The gravel is removed only to such height as is necessary to recover the pay, or, if the pay streak be shallow, only sufficient gravel is removed to permit the work of mining to proceed, and, in many drift mines, low roofs result, the miners having to crawl upon hands and knees into the workings and to work for hours daily in a cramped, stooping position, this being considered more economical than the removal of a larger amount of ground, permitting of more freedom of action to the miner and a corresponding increase of work. Experience has shown that it pays to take out as little ground as possible.

The main gangways are substantially timbered, are often of large size, having two tracks, and in most respects resembling the main drifts of a quartz mine. It not unfrequently occurs that the bedrock of the channel swells upon the removal of the gravel, and this becomes a source of great annoyance and constant expense by reason of the movement and breaking of the timbers and the constant shifting of the tracks. When swelling ground is encountered, selected, heavy timbers are employed, the sets placed a short distance apart; the legs of these are given a very wide spread at the base, sometimes setting at 45° to 50°. This is found to afford the most satisfactory results, and, by frequently relieving the ground as it pushes upward, the sets are kept in fairly good shape. The tracks, however, require constant attention.

Ordinarily the main gangway of a drift mine is carried low—that is, below the general level of the bedrock—because of the inequalities of the latter, it being always desirable to have the main drift and drainage passages as low as the lowest portions of the bedrock along which the workings extend, and also to afford convenience in handling the gravel removed from the breasts which are on either side of the

main gangway. Along the gangway loading platforms are laid, upon which the gravel is thrown by the miners, who, as they proceed, shovel out the small material and pile up the large boulders behind them to assist in supporting the roof. From the platforms the gravel is loaded into the cars standing on the tracks in the main gangway, their tops being usually but little above the loading platform, and sometimes below it.

The posts used in breasting gravel are short and have a stout, heavy cap placed above them. Lagging is inserted between the cap and the gravel, or not, as the case may require. Some ground is so firm as to require no timber support at all, being held up by walls and piles of boulders. In the early days of drift mining in California the business had to be learned; the miners were apt scholars and made rapid progress, but their methods were comparatively crude and necessarily expensive, though with the advance of time improvements were introduced in almost every branch of the business, particularly in ventilation—a most important matter in the system of mining and in the underground haulage of the gravel.

The largest drift mines in California are on the Forest Hill divide, in Placer county. It is estimated that the drift and hydraulic mines of this county on the Forest Hill divide, at Iowa Hill and about Dutch Flat, have produced nearly $70,000,000 in gold. A large area, constituting miles of channel, has been worked and exhausted, but there still remains untouched far more than has been exhausted. Hydraulicking in Placer county has nearly ceased, but drift mining will be continued for many years to come. Whether or not the result of the past operations in these mines constitutes a safe basis for calculation of the value of that remaining, cannot be said with certainty; but, from present knowledge of existing conditions, the outlook for a long continued era of prosperity is more than favorable.

Among the largest and best equipped drift mines of the Forest Hill divide are those owned by the Hidden Treasure Mining Co., whose lengthy tunnels have outlets at Sunny South, Centerville and Damascus. The property comprises a group of claims having a total area of 2328.8 acres. Within this area are several channels, some large, others small, but all rich in gold. These channels lie at various levels and intersect each other, often rendering their identity uncertain, until a large amount of work has been performed. The variation in elevation of these channels and their intersection at various points has given occasion for some unique mining engineering in the development and operation of this extensive property.

The main gangway at Centerville is 3715 feet above sea level at its mouth, and has been driven under the mountain over 8000 feet. The entrance at the Hidden Treasure tunnel is at an elevation of 3641 feet, and it has run into the hill 8500 feet. This tunnel enters the mountain at Sunny South. The Mountain Gate tunnel is at Damascus, on the opposite side of the Forest Hill divide, at an elevation of 3748 feet, and penetrates the ridge over 7000 feet. The summit of the divide is nearly 1000 feet higher than the channels of the ancient streams now being exploited for the gold they contain.

The Hidden Treasure-Mountain Gate channel runs through this property for a distance of 18,000 feet. This was a river of unusual size among the ancient streams, and at one place is more than 1600 feet wide. The greatest width of gravel breasted on this channel is 800 feet, the average being about 400 feet. The bedrock is soft and requires but little powder to break it. On exposure it swells, and, as above mentioned, this proves a source of trouble and expense.

A second important channel, known as the Deep Blue channel, also has great length within the company's lands—its extent having not been determined.

The last annual report of Superintendent H. T. Power shows that during the year the average number of tons of gravel extracted per day was 332, the average number of tons of waste 46, making a

total average of 378 tons. The gravel is breasted to the height of 6 feet. The average number of men employed for the year was 170. The cost of mine timber per day was as follows: Timbers framed and ready to load in cars, $30; one sixth cost of operating electric plant, $2.25; labor, saws, etc., $8.75; total, $41. The average flow of water from the tunnel at Sunny South was 310 gallons per minute. The flow from the tunnel at Centerville was 375 gallons per minute. A ditch three miles in length conveys water from the mine below Centerville to the storage reservoir below Sunny South, for use in developing electric power for traction and other purposes. The flow from the tunnel at Sunny South is also conveyed to the reservoir. The pipe line from the reservoir is 1820 feet in length and consists of 820 feet of 9-inch double-riveted steel pipe, 500 feet of 8-inch and 500 feet of 7-inch standard screw pipe. A 3-foot Pelton water wheel, with flywheel weighing 2000 pounds, works under a vertical head of 850 feet, and is capable of developing 200 H. P. Water is delivered through a cast iron double nozzle, fitted with cut-off hoods, with levers to work successively, connected to a Replogle electric relay governor by rack and pinion. This governor serves the two-fold purpose of economy in the use of water, and that the supply shall be approximately proportioned to the instantaneous demand for power at that point. The water wheel is belted to two general electric direct-current generators, with capacity, at full load, of 50 amperes at 250 volts. It is set to maintain a constant voltage (under all loads up to the capacity of the plant) at the blower plant in the tunnel at Centerville, 14,000 feet distant. A skeleton switchboard, with switches, rheostat circuit-breaker, fuse, lightning arresters, potential and current indicators, is installed. The length of the transmission line from the generator station to mouth of tunnel is 13,000 feet. The size of wire is No. B. & S. gauge. The electric motor car, for traction purposes, which is here illustrated, weighs 6500 pounds. It is fitted with two railway motors of 10 H. P. each, geared to the axles and equipped with brake, switches, controller, electric headlights, etc. The speed at which the tunnel trains are operated varies from six to twelve miles per hour.

At the mine at Centerville a 5 H. P. motor drives two circular saws used for framing mine timbers, making wedges, foot blocks, etc. A second motor of like capacity operates a No. 4½ blower, which forces the air through a line of 11- inch pipe to ventilate the mine. Trains of fifteen to thirty-two loaded cars are taken each trip, the total carload weight being 2700 pounds, viz., weight of car 750 pounds, weight of gravel 2000 pounds.

The trolley is of copper wire, securely fastened to the roof of the tunnel, 6} feet from the rail. The single trolley wire and return rail system is used. The tunnel is laid with twenty-five and thirty pound steel rails, resting on ties 3 feet apart. The present plant is designed for an eventual length of 10,000 feet of tunnel. It is being operated at this time over 7320 feet of trolley line, viz., 6500 feet under ground and 820 feet outside.

With horses the maximum average capacity was 180 tons of gravel per day. The record by electric traction for the six days ending December 3, 1898, shows 3019 tons of material delivered at the dump, or an average of 503 cars per day. This maximum output by no means taxed the plant to its capacity. With animal traction the daily output would decrease as the tunnel advances.

The daily expenses of operating by animal traction is as follows: Two dumpers at $2=$4; four drivers and swampers at $2 25=$9; one stableman, $2.50; feed, shoeing and harness of eight horses at 75 cents =$6; interest and depreciation on capital invested in horses and harness, four years, $1 25. Total daily expense of tunnel operating by animal traction, $22.75.

The daily expenses of tunnel operating by electric traction are: Two attendants at generating station, $4 50; repairs, oil, etc., $1.50; depreciation at ten years' life of mine, $4; interest on capital invested, $3.50; cost of operating plant, $13 50; two thirds cost of operation charged to traction, $9; the

other one-third is properly chargeable to lumber, framing and ventilation, one-sixth each; two motor men, $5.50; two dumpers at $2=$4. Total cost of daily traction by electricity, $18.50; traction by animals, $22.75.

A saving also results from the shorter time required to take the shifts in and out of the mine. From the station in the tunnel it required thirty-five minutes for animals to make the trip, so that seventy minutes, or more than 12}% of the time of the shift, was lost. With electric traction the time of making the round trip is reduced to about thirty minutes, or 5%.

Taking cost of mining at 90 cents per ton by animal traction, the reduction by reason of rapid transit is 6 cents, or a saving of 7%, making the cost 84 cents. By animal traction an average of not more than 180 tons per day could be handled. The cost of material handled, then, results at $22.75 for 180 tons, or 12.6 cents per ton.

By electric traction a daily average is 378 tons at a cost of $18.50—less than 5 cents per ton.

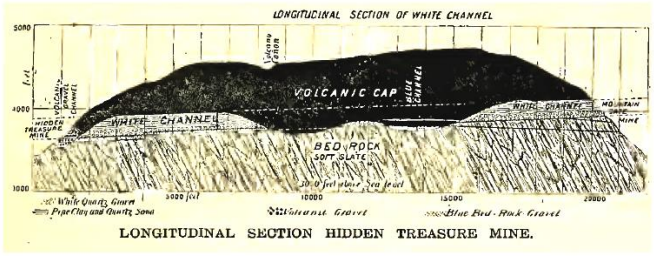
The cost per ton by electric traction is: For mining or extracting, 84 cents; haulage, 5 cents. Total cost, 89 cents.

This shows a saving of about 13 cents per ton in electric haulage.

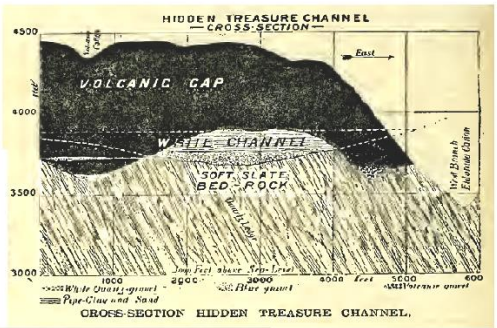
The Hidden Treasure is the most thoroughly and modernly equipped drift mine in California. On the opposite side of the ridge at Damascus the Red Point mine is arranging to put in a compressed-air haulage and ventilating plant.

The principal owners of the Hidden Treasure Co. have recently acquired a valuable addition to their holdings in the purchase of the Morning Star drift mine at Iowa Hill, which is herewith illustrated. The Morning Star adjoins the Big Dipper mine, owned by the same syndicate, the consolidated mines forming a valuable property.

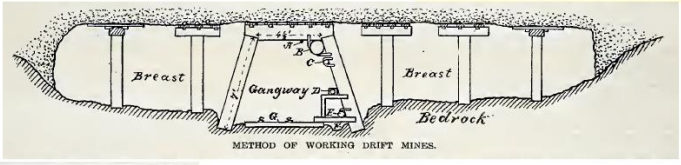
Mining and Scientific Press, V. 79, 11/25/1899, p. 604-606



LONGITUDINAL SECTION HIDDEN TREASURE MINE.



CROSS-SECTION HIDDEN TREASURE CHANNEL.



METHOD OF WORKING DRIFT MINES.

SHOPS, SLUICES, ETC., HIDDEN TREASURE MINE.

GRAVEL WASHING PLANT, HIDDEN TREASURE MINE, PLACER COUNTY, CAL.

ELECTRIC TRAMWAY, HIDDEN TREASURE MINE, PLACER COUNTY, CAL.

ELECTRICALLY DRIVEN SAWMILL, HIDDEN TREASURE MINE.

ELECTRIC LOCOMOTIVE, HIDDEN TREASURE MINE PLACER COUNTY, CAL.

Morning Star Drift Mine, Iowa Hill