ART. XXXIII.—*The Auriferous Gravel Deposit of Gold Bluffs;*
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I PROPOSE to ask your attention, for a few moments, to a brief description of the somewhat celebrated deposit of auriferous gravel on the coast line of Klamath County, California, called the Gold Bluffs, and the method of gathering the beach sands and extracting the gold therefrom, now practised at the two mining claims which are worked there.

Coming from the north, after leaving the Klamath River, the coast line is extremely broken and rocky, the rock being principally metamorphic sandstone, with an occasional cliff of chert or jasper in regular layers or strata. At a point about four miles south of the river, banks and deposits of gravel appear, although the commencement of the bluffs proper is at the mouth of a creek called the Ossegean and seven miles from the Klamath. Then, for nine miles, there is an almost unbroken line of cliffs, varying from 100 to 500 feet in height. Many of the bluffs are absolutely vertical and in some instances overhanging. At low water there is a narrow beach, but when the tide is full the sea washes directly against the base of the cliffs: the beach is then impassable.

The mountains back from the coast, of which the bluffs form the sea-escarpment, are all one immense mass of gravel, of varying size and distinctly marked layers or stratifications. This gravel can be traced across the country, northeastwardly, to a point on the Klamath River about thirty miles distant, where the same form of deposit makes its first appearance as you ascend the river.

As the bluffs are similar or nearly so in stratification, I have sketched a section of one, from under which the specimens of black sand or magnetic iron ore, which on examination you will find rich in fine gold, were taken. (Specimens presented with this paper.) The height of this cliff from low-water mark is about 227 feet, and the sketch represents a vertical section. The thickness of the different strata, I would remark, are by estimation, as I had no available means of determining them with exactitude.

Commencing from the top, we have first a section of ten feet of loam; then twenty feet of yellow clay; then forty feet of coarse yellow gravel; then a stratum of sandstone of brownish color, ten feet; next forty feet of red and yellow gravel; then five feet of a blue-colored sandstone. Projecting from this layer are numerous stumps and other portions of trees, partially transformed into lignite. A specimen of this lignite is presented with this paper. Then we have fifty-five feet of a very coarse red and yellow gravel, and immediately beneath it five feet of very fine blue-colored gravel; then fifteen feet of indurated sand; then ten feet of gravel, stained deep red, probably from the presence of oxide of iron. Beneath this is another stratum of sandstone, five feet, blue in color, with pieces of the lignite before referred to projecting from it; then five feet more of blue sandstone without any lignite; then seven feet of gravelly beach to low water mark.

This cliff which I have described is at the lower end of the bluffs, and near the mining works. The strata all dip to the *north* at an angle of about 15° ; while those on the north end, although much broken, seem to dip toward the south.

A specimen of the stratum No. 10 from the top is presented. You will see by examination that the presence of mica and fine gold can be detected with the microscope. The specimen obtained was a concretion cemented together on a large boulder by the oxide of iron. It is my belief that from this stratum the largest amount of fine gold is obtained.

Before attempting to form any theory as to the origin of this vast deposit of auriferous gravel, I will give a brief description of the history of the gold working of the beach, and the present mode of operation. In 1850, when this portion of the coast line was still in undisturbed possession of the Indian tribes, a party of adventurers travelled from Trinidad up, seeking

for the mouth of the Trinity River, which, instead of being in reality an affluent of the Klamath, was supposed to have a separate mouth. One of the party was J. Johnson, now a resident of Crescent City. At a favorable spot on the beach they saw glittering particles in the sand, and on examination found them to be gold. Gathering some of this gold, they went back, greatly excited, to Trinidad, to procure provision.

On their return, however, they found nothing but a bed of gravel, a change in the direction of the surf having carried away or covered up the glittering treasure. It may be remarked here that when the direction of the wind is such that the surf breaks square on the beach, it rolls up masses of coarse gravel, and no black sand is visible; but that, when it cuts the beach at an angle, the gravel is washed into heaps in certain spots, and in others black sand is deposited, more or less rich in gold.

After this discovery ensued the so-called "Gold Bluff excitement." The first mining claim was taken up the same year by Bertrand and Nordhamer. The beach sands were worked with sluices, the gold being caught in riffles sawed in a plank, loaded with quicksilver. From that time to the present these beaches have been steadily worked; the highest amount taken out in any one year, up to the present, being said to be \$25,000, for the lower claim. The proprietors have, however, labored under the disadvantage of a scanty supply of water, not being able to keep their sluices running more than one-third of the time. I will now give a description of the present method of working, as witnessed by myself.

I rode up the beach with the superintendent of the lower claim, just as the tide was turning to go out. His practised eye noted every indication of the presence of black sand. Alighting at a spot at the base of the cliff, a section of which I have just shown you, he scraped away the loose gravel and taking up a shovel-full of the sand lying beneath, panned it out in a little pool of water left by the receding tide. A rim or circle of fine gold around the spot of sand indicated the richness of the layer. A messenger dispatched to the works soon brought down the mule train. There are some forty animals employed, although in the present instance but sixteen of them were used. Each mule carried a couple of sacks of coarse canvas attached to the pack saddle. Each sack will contain about 150 lbs. of sand and gravel; the mule packing therefore 300 lbs.; and the train of sixteen, 4800 lbs., or nearly two tons and one-half at a trip.

The top gravel being stripped off, the underlying sand was gathered into little piles. While the men were thus engaged the superintendent invited my attention to the appearance of

the bed-rock or hard strata underneath the sand after it was stripped. It glittered with fine particles of gold, and I could then well believe the stories of the first discoverers.

So exceedingly fine, however, is the character of this gold, that it requires a much larger quantity of these particles to reach the value of a cent than one not familiar with the subject would suppose. Specimens of the sand as taken from the beach are presented with this paper. On microscopic examination, besides the gold and magnetic iron ore, the sand will be seen to contain minute and brilliant red particles, which I believe to be spinel in some of its forms. Other translucent particles will be seen.

Prof. Silliman, in notes on the Mineralogy of California, Utah and Nevada, mentions a variety of minerals as composing the black sands of Butte County. It is probable that all or nearly all of these will be found in the sands from Gold Bluff. As there are large deposits of chromic iron in the county adjoining, it is probable that chromite forms a portion of the black sand.

Prof. Silliman mentions syenite as the matrix from which most of the minerals he enumerates came. I present a small pebble of syenite from Gold Bluffs. It is a common factor in the gravel masses.

To return now to the description of the process of gathering the sand. After it had been, as mentioned before, shovelled up into little piles, the canvas sacks were taken from the mules and filled. With a word from the driver each mule gravely walked up between his sacks. On their being placed on his back he would start off on a trot, for the works. I watched the movements of these animals with a great deal of interest: they had to pass several points where the sea was breaking pretty well up on the bluff. When they saw a heavy breaker coming in they would face the cliff like veterans, and, with firmly braced feet and drooping ears, allow the water to dash over them; when the swell receded, off they would start again. During the time I was present these mules made three trips, carrying up on the whole some six or seven tons: this was on a single tide.

On arrival at the works the sand is deposited in an enclosure called the "sand corral." A large lagoon near by supplies the necessary fresh water for separation. A small stationary engine and force-pump is in use. The washing is done in machines called Long Toms, the gold being caught on copper plates which are charged with quicksilver. Formerly it is believed that a large percentage of the gold, ground down as it was by the wearing action of the surf to a powder, was lost. Now the plates are first coated with a layer of silver before the mer-

cury is applied. Sodium is also used to free the quicksilver from impurities. A ton of the tailings, analyzed in San Francisco after this improvement had been effected, did not afford a trace of gold. The copper-plates in use, especially in the old process, become quite valuable after continuous service, the copper being replaced by an almost pure amalgam of gold and quicksilver.

During the week that I was in the vicinity of the works, they cleaned up a six or seven days' run and retorted \$1600 from the washing of the two machines, each employing two men. The succeeding week they cleaned up \$1700. Of course this yield comprised the gold from a portion at least of the rich deposit I have described.

Since the experience of the successive proprietors of this extraordinary gold mine go to prove that immediately after a heavy cave or slide of the banks, the beaches are richer and the gold coarser, it seems strange that up to the present time, no artificial means have been resorted to, in the way of blasting down the cliffs or undermining them by hydraulic power, to increase the yield of gold. The sea working night and day is the great natural separator, and man has but to gather the results of its tireless work.

Many ideas have been advanced as to the possibility of gold in quantities and coarser in character being found beyond the lines of surf, predicated on the fact that *it* in conjunction with black sand has been said to have been brought up from the bottom by the leads of sailing vessels, and I believe an expedition was fitted out to obtain this sand by means of a diving-bell or some such apparatus, which did not result favorably.

Two or three facts can be taken in conjunction here to form an idea on this subject. The first is that the gold evidently comes from the bluffs. This no one can doubt after once viewing them. The second, that after "caves" the gold obtained is much coarser in character. The third, that it is only after a continued succession of swells that cut the beach at an angle, that the rich sands are found. When the surf breaks square on, let the storm be ever so heavy, it simply loads the beaches with gravel. The fourth, that no one witnessing the power of the surf breaking as it does with no rocky headlands, points or rocks to deaden it, can doubt that it must have an immense grinding force. From these facts I am inclined to believe that the gold follows the first two or three lines of breakers and will never be found in paying quantities beyond. As you will see by examination of the specimens, this gold is so light in character that when dry it will float on the surface of water.

In endeavoring to account for the presence of these remarkable gravel banks, unique I believe on the Pacific coast, one

is inclined to think that they were the deposits of a great river of the past, occupying the bed of the present Klamath, but having its debouchure here. The fact that the gravel is flattened and oblong in shape as a rule, the presence of lignite in different strata and of river sand in others, would go to confirm this theory, although the broken and disrupted character of the mountains back is an evidence of after disturbance.

I present a fossil vertebra, obtained from the bank mentioned, which may throw some light on the subject. Whatever may have been the origin of these deposits, and I do not profess from lack of experience to form a definite opinion, it is certain that they offer an inviting field for the geologist and will some day demand careful study.

After the completion of this paper, I received a letter from Prof. J. D. Dana, to whom I had sent specimens of the sands of Gold Bluff, from which I extract the following remarks:

"The red grains in the sand are garnet. It is altogether probable that the deposit dates *partly* from the close of the Glacial era; that is, the time of melting of the ice in the early part of the Champlain period, when floods and gravel-deposition were the order of the day, and *partly* from the later part of the Champlain period, when the floods were but partially abated, yet the depositions were more quiet."