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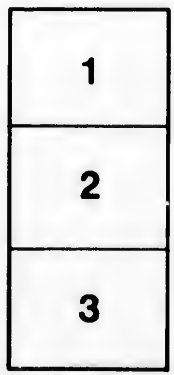
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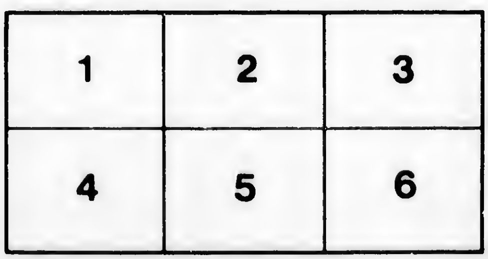
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"GOLD,"

ITS PROPERTIES, MODES OF EXTRACTION, VALUE, &c., &c.

———o———

BY

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———o———

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PREFACE.

Although this is a gold producing country, and the precious metal passes through the hands of so many, there is, doubtless, a large number of persons quite uninformed with respect to the conditions under which gold occurs in nature, the various processes by which it is obtained, and its commercial value after it has been collected.

This little pamphlet has been written with the view of presenting the subject to the Public in as condensed a form as possible, in order to enable those who cannot spare the time, or who may not have the patience, to read through a large work, to acquire, by the perusal of a few pages, an insight into some of the most important features of an interesting and useful Branch of Study.

History and Properties of Gold.

Gold has been known from the earliest ages of the world, and has been universally employed as a medium of exchange.

We hear of its having been used by the Hebrews, Egyptians, Greeks, Romans and other ancient nations, in about the same manner as it is at the present day. The first allusion made to gold in the Bible occurs in the 2nd chapter of Genesis, v. 11 and 12. But the earliest practical application of the use of gold appears to be that mentioned in the 24th chapter of Genesis, v. 22, B. C, 1857, where it is evident that the precious metal was not only known but wrought. Eleazer, the servant of Abraham, gave to Rebecca, the future wife of Isaac, an earring and two bracelets of gold. It is also mentioned by Moses in the 31st chapter of Numbers, where he says, "Only the gold and the silver, the brass, the iron, the tin, and the lead, everything that may abide the fire, ye shall make it pass through the fire and it shall be clean." The alchymists designated it by the name, and gave it the symbol of Sol.

It is the most precious of all the metals, possesses a beautifully rich yellow color, and has no perceptible taste or smell. When pure its specific gravity is 19.3, being, with the exception of Platinum and Iridiam, the heaviest of all known substances. In its native state the specific gravity varies from 13 to 18.

It is pre-eminently ductile and malleable; so malleable that it may be beaten out into leaves so thin that one grain of gold will cover 57 square inches; so ductile that a single grain weight may be drawn into a wire 500 feet long.

It fuses at a temperature estimated at about 2020 degs. Fahrenheit.

Gold is invariably found in the metallic state, but is never quite pure, being alloyed with silver in different proportions, and being generally associated with small quantities of copper, iron and other metals.

There are other combinations of gold, which are, however, of comparatively small commercial importance. One, an alloy of gold with Palladium, called Palladium gold, another with Rhodium, called Rhodium gold.

There is also a native amalgam of gold and mercury. The *Electrum* of Pliny, so called by him on account of its amber color, seems to be a definite compound; specimens from Siberia, analyzed by Klaproth, were found to contain 64 parts of gold and 36 parts of silver.

There are few parts of the globe in which gold has not been found more or less to exist, but it occurs very irregularly, here and there in great abundance, in some places in minute quantity. Prior to the great Californian discovery, in 1847, various countries in Europe, Asia, Africa and America had contributed large supplies of the precious metal, the most celebrated mines of which, in Europe, are those in Transylvania, which have been worked since the time of the Romans.

There are mines in various parts of Africa: those on the Mozambique Coast are supposed by some historians to have been the famous Ophir of the time of Solomon. Subsequent to the discoveries in California and Australia, the old gold mines have become of comparative insignificance, as these two regions now produce more than four times the amount yielded by all the other countries put together.

Further discoveries of considerable importance continue to be made, among which those in British Columbia occupy a prominent position.

Gold is largely obtained from alluvial washings, in the shape of fine particles and water-worn plates and scales, but crystallized specimens are occasionally met with. These crystals are in forms belonging to the monometric system, such as cubes and octahedrons, generally the latter. Sometimes larger lumps, or "nuggets," are found, weighing several ounces, and in a few rare instances, many pounds.

Geological Position of Gold.

There are four different lithological situations in which gold occurs :—

1. In veins, generally enclosed in metamorphic slates.

2. In small threads, traversing the quartzose veins of the more highly crystalline rocks.

3. In placer deposits formed by ancient river-systems, known as "deep diggings."

4. In placer deposits, distributed by the present river-system, giving rise to what are called "shallow diggings."

The most productive gold-bearing quartz is generally found to be that which intersects talcose, chloritic and argillaceous schists, although valuable gold veins are occasionally met with in granite, gneiss and porphyry.

These veins have most frequently the same "dip" and "strike" as the slaty rocks in which they are enclosed. Their width varies from a fraction of an inch to several feet, some have been known to attain the extraordinary thickness of a hundred feet; and their richness in gold is equally uncertain.

When rocks remain stratified, in nearly the same position in which they were originally deposited, they are rarely found to be highly auriferous; but when they have been upheaved, or raised on edge, by eruptive masses, and have assumed a crystalline texture, there is good reason to expect the presence of the precious metal.

The auriferous veins are presumed, by some geologists, to have originated at the time of the metamorphic action, by which the change in the strata was effected. This action does not, however, appear to have been confined to any particular geological epoch, and it is probable that these alterations, which are most likely very slow in their progress, may have been repeated at periods of time exceedingly distant from each other.

The widest veins are not usually the richest, and it has been found that some of the laminœ running parallel with the enclosing walls are uniformly more productive than others. It therefore not unfrequently happens that a portion of a vein, rich enough to be treated with advantage, is separated from another band, comparatively worthless, by a distinct heading, or false wall.

As a general rule those veins are most productive which afford considerable quantities of sulphides; although, near the surface, these have, almost invariably, become decomposed, thereby liberating the enclosed granular gold, and staining the quartz of a brown or reddish color.

When gold is found in white quartz, without sulphides, it is in most instances in flakes and granules of considerable size, and is consequently visible to the naked eye; but such veins, although affording fine specimens, are not often regularly and remuneratively productive.

The most profitable veins are generally only of moderate size, and seldom exhibit visible gold.

It was formerly believed that veins of auriferous quartz become gradually less productive as greater depths from the surface are attained, but experience has shown that this is in reality not the case. It is true that gold mines have fluctuated considerably in their richness at different depths, but it has not been found that these variations correspond with a gradual impoverishment in the deeper levels.

An illustration of this fact is found in many veins in California.

The North Star vein is now worked on its inclination to a depth of 750 feet, and affords quartz yielding, on an average, gold of the value of $35 per ton of 2000 lbs., whereas in the upper levels the value did not exceed $20 per ton.

Hayward's mine, in Amador County, is another still more striking instance of the produce of a vein not decreasing as it goes down. This ledge has been worked on its inclination to a depth of over 1250 feet, and yields quartz of much greater value than that obtained from the same vein nearer the surface.

The yield of the quartz veins of Victoria has also not been found to decrease in depth. Some mines have been worked 500 feet from the surface and have experienced no diminution in their produce.

The greater portion of the gold of commerce, however, is derived from "gold-washings," or the separation of the metal from the superficial detritus, which is included by Geologists among the drift and alluvial deposits.

The process by which these auriferous deposits have been formed is a question which has not yet been satisfactorily solved.

The prevailing opinion is that, by various operations of nature, the gold has been broken away from the rock or vein in which it was elaborated, and has been carried by water some distance and then deposited along with the fragments of the rocks and minerals with which it was associated.

Professor Whitney says: "The separation of the gold from its original matrix and its deposition among the strata of gravel, sand and clay, or beneath them upon the surface of the rock, has been the result of causes acting through an immense period of time; and which have not yet ceased to operate, although their energy seems no longer equal to what it must have been at a former epoch. The rocky strata if the earth are constantly undergoing abrasion from the combined action of various meteorological causes; of which one of the most powerful at present is the alternate freezing and thawing of water in fissures and cavities, which tends to wear away and disintegrate the most elevated portions, especially of the slaty beds, and to carry down the abraded and loosened materials, and spread them out in the adjacent valleys. In lofty and rugged mountain chains, where torrents of rain frequently fall, and the streams, suddenly swollen to a great volume, rush with tremendous violence down rapidly declining valleys, their force becomes capable of wearing away the rocks with great rapidity."

"This mechanical action is frequently aided by a chemical one; the strata undergoing a molecular change which softens them and renders their abrasion easy. As the enclosing rocks are thus worn away, the quartz-veins become disaggregated by the oxidation of the iron they contain, and are themselves crushed into fragments and borne down into the valleys, where the metallic particles, having by far the highest specific gravity, are first deposited and sink to the bottom, while the lighter earthy portions are carried farther."

Sir Roderick Murchison asserts that the more or less superficial deposits which contain gold, and known as "deep diggings," are not to be confounded with detritus formed by present atmospheric action, but rather that they are the result of diluvial currents connected with, and originating in, physical changes in the earth's surface, such as the elevation of mountain chains.

Another explanation of the formation of deep diggings has been advanced by Davison, which is perhaps entitled to a certain amount of consideration, although the great majority of Geologists incline to the opinions of Sir Roderick Murchison and Professor Whitney.

Davison asserts that placer gold has been distributed and deposited by means of some igneous liquid rock, or lava, and that quartz-veins and dykes have been the fissures of discharge.

His reasons for this conclusion are, that alluvial gold often has a fused appearance, and has a ragged and irregular surface, which must have been destroyed by abrasion; that it is found upon "bed rocks" in such shape and position that the agency of water alone could not have so placed it, and that it also occurs richly deposited in the neighborhood of ancient volcanic disturbance.

However much Geologists may differ with regard to the origin of "deep diggings," there can be no doubt that the distribution of gold by the present river-system, constituting the "shallow diggings" is purely referable to the natural grinding away of auriferous rocks, and the deposition of the gold by the agency of water.

Extraction of Gold.

Gold mines may be divided into two distinct classes, viz: placer mines, in which the metal is found embedded in clay, sand, or gravel; and quartz or vein mines, in which it is met with in its original matrix.

In the former, the gold producing material is called "pay-dirt," which on being subjected to the action of water, becomes disintegrated, and the lighter portions are mechanically carried off, whilst the gold, being heavier, remains behind.

In the latter, the rock has to be first obtained by the ordinary mining operations, as practiced with regard to other metals, then reduced to powder by mechanical means, and finally the gold is collected, either by washing or amalgamation.

Placer mines are generally those which first attract attention in a new country, and from which profitable returns are most easily obtained.

Water is the great agent by which placer mining is carried on.

These mines are of two classes, the shallow and the deep; the former are generally found in the beds of ravines, on the bars and in the beds of modern rivers, and on shallow flats.

In the latter, the pay dirt is often found at great depths from the surface, and is frequently covered by thick beds of lava, or volcanic ash, as in the case of the deposits under Table Mountain, Tuolumne County, and near Nevada City, California.

In the deeper placers, the gold drifts are reached either by shafts, or by means of tunnels. The pay dirt is thus extracted, conveyed to the surface and subjected to the process of washing.

In other instances, hydraulic mining is resorted to. Jets of water, under a great presure, obtained from a high column, are directed against the deposits of sand and gravel, which are thus disintegrated and carried away by the current.

This is the most econemical and expeditious method of working placer mines, when a sufficient supply and pressure of water can be obtained, and there is enough declivity below the auriferous beds to allow of the detritus being readily disposed of.

The pay dirt is almost invariably covered by layers of barren clay and sand, which are, in the shallow diggings, removed by the use of the pick and shovel; but in hydraulic workings, the whole is washed away by the force of a stream of water playing against it, and any particles of gold which it may contain are caught in the sluices through which the lighter materials pass.

According to their topographieal position, placer mines, besides being classed as shallow and deep, are subdivided into hill, bench, flat, bar, gulch and river diggings.

Hill diggings are in the sides of hills; bench diggings are on narrow benches on the declivities of hills, and above the level of existing rivers; flat diggings are those on flats or small plains; bar diggings are usually in sand and gravel, on the sides of streams, and, ordinarily, above the surface of the water; gulch diggings are found in ravines and gullies, through which water passes only in times of excessive floods; river diggings are those which exist in the beds of rivers.

The terms sluice, hydraulic, tunnel, dry diggings, &c., are used to describe the different means employed for reaching the auriferous deposits, and separating and collecting the gold.

The most simple appliance for the separation of gold is the well-known pan, which is used either for washing or as a receptacle for gold, amalgam, &c. After a certain amount of practice the miner is able to get rid of the whole of the sand, clay and stones, retaining in the angle of the pan the gold and a small quantity of black sand, which is too heavy to be separated from the gold by washing. It can, however, after drying, be, to a great extent, removed by the process of blowing and the use of the magnet.

The cradle consists of a box usually about forty inches in length and twenty in width, with one end from fifteen to twenty inches in height, the sides being sloped off at the lower extremity like those of a coal-scuttle, the whole standing on rockers.

At the upper end of the cradle is the hopper, or riddle box, twenty inches square and six in depth, of which the bottom is composed of sheet iron, perforated with holes half an inch in diameter. This is not fastened to the cradle, but can be lifted on and off at pleasure and fits in so as to be quite steady when in its right position.

Beneath the riddle is an apron, made by stretching a piece of canvass on a framework resting on fillets, inclined from the bottom edge of the riddle towards the head of the cradle. Across the bottom are two riffle bars, about three-quarters of an inch in height, one towards the middle, and the other at the lower end.

The dirt is shovelled into the hopper, and the miner rocks the cradle with one hand, whilst with the other he pours water upon the dirt. The action of the water and motion together disintegrates the dirt, which passes through the riddle and falls upon the apron, finally escaping at the lower end, leaving the gold, black sand and heavier particles of gravel behind the riffle bars. Mercury is sometimes used in the rocker but is not generally recommended.

But by far the most important arrangement is the sluice, which is now almost universally employed for the collection of gold from placer mines.

The sluice is a long wooden trough, having a considerable inclination, into which the pay dirt is shovelled, and through which a rapid stream of water is continually flowing. At the bottom of this trough is a series of riffles, generally containing quicksilver, by which the gold is retained, whilst the clay, sand and gravel are carried off by the force of the current.

The ordinary sluice is composed of a series of rough wooden boxes, each twelve feet in length, and from sixteen to twenty inches in width, and from ten inches to a foot in depth.

The descent of a sluice is called its "grade," and is commonly from ten to eighteen inches on each box of twelve feet in length. This "grade" is regulated by the position and length of the apparatus and the nature of the dirt to be washed.

It is important to guard against giving too great an inclination, as there would be danger of losing the fine particles of gold; while, when clay is present in quantity, a small inclination will not easily effect its disintegration. A good deal of practice and judgment is obviously necessary to ensure the smallest loss of gold.

As a general rule, however, a fall of less than ten inches, or more than twenty inches, on the length of a twelve-foot box, is not suitable for the ordinary sluice.

If the pay dirt contain large blocks of stone and boulders, a large body of water and a rapid current are required. The upper part of a sluice is sometimes made steep in order to effect the disintegration of the dirt, whilst the lower is placed at a less inclination for the purpose of collecting the gold, and this arrangement is often found advantageous.

When the clay is very tenacious and rolls into balls, the lumps should be broken up at the head of the sluice, as balls of plastic clay, passing through the boxes, not only retain any particles of gold they may contain, but are also liable to pick up others over which they may pass in their course.

Sluice boxes are provided with a false bottom for the purpose of retaining the gold, which would otherwise not only be taken away by the force of the current, but the bottoms themselves be rapidly worn out by the attrition of the stones and gravel passing over them.

Generally these false bottoms consist of longitudinal bars, from two to four inches in thickness, from three to seven inches in width, and about five feet and a half in length. They are wedged in the boxes, an inch or two apart, by cross pieces, so that two lengths of bars are fitted in the bottom of each box.

In the depressions thus formed, the gold, mercury, and amalgam are caught. When the sluice boxes have been all joined together, and the bars wedged into the bottom of each, the apparatus is ready for working, and the pay dirt is shoveled in at the head.

About an hour or two after the commencement of sluicing, some quicksilver is poured into the head of the apparatus, whence it gradually finds its way downwards. The greater the amount of fine gold present, the larger must be the quantity of mercury used. Small quantities of quicksilver are also sometimes introduced between the bars and various other places in the boxes.

When the gold is exceedingly fine an amalgamated copper plate is sometimes resorted to. This plate is about three feet by six, is set nearly level, and, when the sluice is very large, the stream is frequently divided into two or three separate portions, each of which is conducted over a distinct amalgamated plate. A well amalgamated copper plate is considered as effective for saving fine gold, as an equal surface of pure mercury, and is not only cheaper, but also more easily managed.

The amalgamation is effected by washing the plate with dilute nitric acid, and then rubbing on, with a rag, quicksilver, on which a little diluted nitric acid has been first poured. When a plate has been once well covered, this operation need never be repeated, it being only necessary to sprinkle its surface occasionally with a little fresh quicksilver, in proportion as the gold caught converts it into a solid amalgam. In order that these plates should work well, the current should be slow, and the water shallow, otherwise a considerable portion of the fine gold might escape without coming in contact with the face of the plate.

The collection of the dirt which accumulates in the bottom of the sluice, and the separation from it of the gold, amalgam, and quicksilver, is called the "cleaning-up," and the time between one cleaning-up and another is called a "run." A run commonly lasts about a week, and the cleaning-up is not unfrequently reserved for the Sunday. This occupies about half a day.

The amalgam and mercury taken from the sluice are first separated from any sand, &c., by panning, then strained through buckskin, or close canvas, which allows the quicksilver to pass through, but retains the amalgam.

To obtain the gold, the amalgam is heated to volatilize the quicksilver; the gold is left in the form of a porous mass of a light yellow color.

This operation is most economically performed in a cast iron retort, provided with a refrigerator, by which the mercury is condensed and can be collected for subsequent use. But the miners often drive off the quicksilver by simply heating the amalgam in a shovel.

In small sluices, the bars are sometimes placed in a series of zigzags, instead of longitudinally or transversely.

The "under-current sluice" is a modification which is often found advantageous.

A grating is placed in the bottom of the lower extremity of the last box in the series, and beneath this is introduced another sluice with a lower grade and fresh supply of water.

The impetus acquired by the large boulders, in the first sluice, causes them to roll off over the grating, and, together with a portion of the water, to escape at the lower end; whilst the introduction of clear water, the less inclination, and more moderate current, arrest many particles of gold that would, under ordinary circumstances, be lost.

There are also "rock sluices," but they are more difficult to clean up.

In "tail sluices" stone bottoms are used, having an inclination of about an inch to the foot. To clean up it is necessary to remove the stones. Tail sluices are used for collecting gold still retained by the dirt which has passed through the ordinary sluice. They are only cleaned up at the end of several weeks, and only require attention sufficient to prevent their choking. They are generally large, long, and paved with blocks of stone, or wood placed on end, and often afford large profits to their proprietors.

"Ground sluices" are used in localities where there is a large supply of water, plenty of pay dirt of low produce, and the necessary declivity.

A small gutter is first made with a certain inclination, and into this is directed a stream of water, by the action of which the channel rapidly becomes deepened and enlarged.

No mercury or riffles are employed in the ground sluice, but unless the bottom consists of a rough and irregular bed rock, some large stones should be roughly thrown in for the purpose of arresting the gold, which, if the surface were not uneven, would be liable to pass off and be lost.

In "river mining" the stream of a river is turned by means of a dam in connection with a ditch or large wooden flume. The dirt is subsequently washed.

The streams selected for this purpose are generally mere mountain torrents, of which the banks are steep and irregular.

This sort of mining can only be successfully carried on during the summer and early fall, when the water is not only low, but when there is also no danger of a sudden freshet which might sweep before it, flume, dam, and tools together.

Hydraulic Mining.

In order to treat most successfully the extensive beds of detritus forming the deep placers, the following conditions are involved:—

1. Whatever may be the depth of the auriferous gravel, the whole must be removed down to the bed rock.

2. This must be effected by the force of a column of water, manual labor being too expensive for the purpose.

3. The mechanical disintegration of the more or less indurated gravel must go on at the same time as the washing of the resulting debris, and be effected by the same supply of water.

4. Provision must be made for readily disposing of the large amounts of refuse resulting from the removal of such vast masses of auriferous gravel.

To fulfil these conditions, after having selected a sufficient extent of suitable ground, water is brought from a canal, by side flumes or aqueducts, to the head of the mining ground, with an elevation of from 120 to 160 feet above the level of the bed rock, where it is conducted into a wooden tank, into which it constantly flows. This box is provided with a valve from which the water is conveyed to the bottom of the claim by means of a strong sheet iron pipe, from eight to fourteen inches in diameter, communicating at the bottom with a thick rectangular cast iron chamber, in the sides of which are apertures provided with slide valves and union joints, to which are fitted strong flexible hose, terminating in bronze nozzles from two and a half to three inches in diameter.

The hose are usually made of closely-sewn heavy duck, and will, without external support, bear the pressure of a column of about fifty feet in perpendicular height. When, as is frequently the case, the pressure employed is greater than this, they require to be strengthened by iron rings. When so made, the hose will support the pressure of a column a hundred and eighty feet in height. Sometimes a netting of cord is used instead of iron rings.

Streams of water are directed from the nozzles against the face of the gravel to be washed, with a force which is astonishing. Very often four or five such streams are made to act simultaneously, under a pressure of from 60 to 100 pounds to the square inch, against the face of the same bank.

Large masses of gravel are thus brought down, which fall with violence, rendering it necessary for the workmen to exercise great caution to avoid accidents.

The debris thus produced becomes rapidly disintegrated and is carried forward by the force of the water to the sluice, through which it passes with the whole volume of the turbid stream.

Banks of more than 80 feet in height are usually worked in two benches.

The upper half is never so rich as the lower, but is, as a rule, less compact and more easily removed by the action of the water. Sometimes the lower section is so indurated that it requires the aid of gunpowder to loosen it.

The sluices employed in hydraulic mining are made wider than those used for other purposes, and are sometimes provided with wooden riffles, kept apart by slips of wood. In some the bottoms are paved with stone.

The gold is collected in the cavities formed by the different blocks of wood constituting the riffles. Between these riffle blocks quicksilver is placed.

Experience has proved that a larger proportion of the precious metal is collected by this than by any other process, and at the same time the cost of handling a cubic yard of dirt is infinitely less.

As an evidence of the immense advantages of the hydraulic process over every other system of placer mining, it may be stated that the comparative cost of handling a cubic yard of gravel will be nearly as follows:—

With the pan....................	$20 00.
" rocker....................	5 00.
By hydraulic process................	05.

Vein Mining.

Having given, it is hoped, a tolerably clear idea of the various processes of gold washing, it is not proposed in the present little treatise to furnish more than a short description of the operations of vein mining, for the subject of quartz, or vein mining, is one of such magnitude and importance, that justice could not be rendered to it without enlarging this pamphlet to a size far exceeding that which was originally intended.

In vein mining, the miner undertakes through his own skill and industry, by breaking up the original matrix and extracting the precious metal which it encloses, to effect that which, at some earlier period of the world's history has, in placers, been done for him by nature on a gigantic scale.

The processes employed for the extraction of gold quartz, are identical with the ordinary mining operations in use for working regular mineral veins.

From the irregularity of the produce, it is impossible to ascertain the average yield of a vein without crushing and experimenting on large quantities.

But to judge, approximately, of the value of rock, a small quantity is pounded up fine and sifted. The sieve is examined to see if any flattened grains of gold remain on it.

The sand or powder thus obtained is washed in a shallow iron pan. Most of the gold is thus left in the angle of the pan. By continuing this process upon successive quantities of pulverized quartz, and when the bulk has been reduced to a manageable quantity, the gold is amalgamated with quicksilver, the amalgam strained to separate excess of mercury, and finally heated to expel the whole of it, leaving the gold.

After concentrating the gold in a small quantity of sand and pyrites, the residue may be subjected to the fire assay, by which, of course, a much more accurate result can be obtained than by amalgamation.

The processes employed for the extraction of gold are various. The two principal methods are "amalgamation" and "chlorination."

Amalgamation in Arrastras.—This is an old method used by Mexican gold miners, but it gives tolerably good results. It is useful for testing the value of newly discovered quartz veins.

The arrastra consists of a circular pavement of stone about twelve feet in diameter, on which the quartz is ground by means of large stones dragged in a circular way by chains, fastened to four arms of a strong upright wooden shaft.

One of these arms is made sufficiently long to allow mules to be attached for working the machine. Round the stone pavement are wooden sides about two feet in height.

Six to ten revolutions per minute are performed by the blocks of stone, each of which weighs from three to four hundred pounds. One and a half to two tons of rock, which has been previously broken in pieces about the size of an egg, can be ground in 24 hours.

The arrastra is charged with about two hundred pounds of quartz, and is set in motion, a little water being added from time to time.

When the ore has assumed the consistency of thick cream, quicksilver is sprinkled over its surface in the proportion of one ounce and a half for every ounce of gold supposed to be contained in the rock.

The grinding is then continued for about two hours. When the amalgamation is considered complete, water is admitted into the paste so as to render it thin, and the machine is turned more slowly, to allow the particles of gold and amalgam to sink to the bottom. After about half an hour the thin mud is allowed to run off, leaving behind it, in the bottom of the arrastra, the gold combined with the quicksilver in the form of amalgam.

Another charge of broken quartz is now put in and treated in the same way, and so on till it is thought desirable to stop to clean up. Sometimes one hundred to one hundred and fifty tons are thus worked through in one "run."

Amalgamation in Iron Pans.—There are several kinds of pans, named after their different inventors, among which the Wheeler pan occupies a favorable position.

The two conditions, friction and contact with mercury, are accomplished in a high degree in this pan, by which as much as 95 per cent. of the gold present is obtained.

Amalgamation in the Battery.—The battery or stamping mill consists of a series of heavy pestles, working in a rectangular mortar, each of which is alternately lifted by means of a cam, and then allowed to fall with its own weight upon the quartz, which has been previously broken up in small lumps. The number of blows struck by each stamper is from 60 to 80 per minute.

The batteries are provided with amalgamated copper plates, three to five inches wide, having the length of the battery; one on the feed side and the other at the discharge, the former being protected by the iron feed plate. They each incline at an angle of 35 to 40 degrees towards the stampers.

The quantity of quicksilver required depends upon the quantity of gold in the ore. Each ounce of gold takes one, to one and a half, ounces of quicksilver, which is introduced from time to time by the feeder, during the stamping.

By this process 60 to 75 per cent. of the gold present may be extracted.

In some places the rock is crushed without the use of quicksilver in the mill. The sand and water issuing from the battery are conducted over blankets spread on the bottoms of shallow troughs, inclined at an angle of three or four degrees. Beyond the blankets there are generally riffles or amalgamated copper plates to catch the gold which may have escaped the blankets.

The stampers are generally kept at work day and night, and the cleaning up of the battery takes place about once a week.

When quicksilver is used in the battery, a large proportion of the gold obtained is taken from it in the form of amalgam, and even when this metal is not introduced a considerable percentage of the the produce is obtained in cleaning up, having accumulated in the cavities around the dies in the shape of metallic spangles.

The coarser the gold in the rock, the larger is the percentage of the total produce retained in the battery.

The "Chlorination process" gives satisfactory results when the gold is in a finely-divided state. It is especially used for ex racting the gold from tailings, and is based on the property of chlorine, of combining with gold, forming terchloride of gold.

The tailings are first roasted to expel the sulphur, arsenic, &c., sometimes a little salt or charcoal is added, the former, however, causes a loss of gold.

After six to eight hours roasting the ore is spread out to cool, and then sprinkled over with water and turned over till regularly and suitably moistened.

The stuff is then introduced into tubs about seven feet in diameter and twenty-five or thirty inches deep. These tubs have false bottoms through which chlorine gas is allowed to enter into the mass of damp tailings. At the bottom of each tub are two holes; one for the introduction of the chlorine, the other for running off the solutions.

The gas is made from a mixture of salt, peroxide of manganese and sulphuric acid, and the evolution is kept up from twelve to fifteen hours, during which time the tubs are covered.

The covers are then removed and clean water introduced until it reaches the surface of the tailings, when the discharge pipe is opened and the liquid, containing the dissolved chloride of gold, is drawn off into glass vessels.

Sulphate of iron is added, which precipitates the gold as a brown powder, which is easily separated by decantation and filtration, and then melted into bars which are about 995 fine.

DETERMINATION OF THE VALUE OF A SPECIMEN OF GOLD QUARTZ, WITHOUT DESTROYING THE SPECIMEN.

Let a represent the specific gravity of the metal.
" b " " " " " stone.
" c " " " " " lump.
" w " " weight of the "
" x " " " " gold.

$$\text{Then } x = \frac{a\,(c-b)}{c\,(a-b)}\,w$$

The specific gravity of the metal and that of the stone have of course to be assumed, as they vary according to circumstances.

As a general rule in these calculations the former is taken at 19, the latter at 2.6. A convenient way of taking the specific gravity when no apparatus is at hand, is to fill a glass vessel with water, to a mark. Then pour, or draw off into another smaller vessel, so much of the water as will allow you freely to insert the specimen. After this, fill up to the mark again, from the water drawn off. The remainder of drawn water is exactly equal in bulk to the specimen; the weight of that water, therefore, gives the divisor, the weight of the dry specimen the dividend; the quotient is its specific gravity.

Calculations of the Value of Gold.

In the United States the value of gold is based upon the formula that 387 ounces of pure gold are worth \$8,000; one ounce of pure gold is therefore worth \$20.6718346.

To find the value per ounce of gold of any given fineness it is only necessary to multiply this sum by the fineness required and divide by 1000.

Thus, to find the value of American Standard, 900 fine, multiply \$20.6718346 by 900 and you obtain \$18. 6046511.

In the United States Mints, the value of gold is calculated from the "standard" weight, viz: the weight of the bullion 900 fine.

Forty-three ounces of standard gold are worth \$800; therefore if the number of standard ounces are multiplied by 800 and divided by 43 the value is obtained.

For example, if it be desired to find the value of 258 ounces, 875 fine, multiply by 875 and divide by 900 to obtain standard, then multiply by 800 and divide by 43 to arrive at the value in dollars:— Thus:—

258 x 875 = 225750 = 225.75 ozs. of fine gold.
225750 ÷ 900 = 250.83 ozs. of standard.
250.83 x 800 = 20066400.
20066400 ÷ 43 = \$4666.60.

The "net" value of gold bullion is equal to the value of the gold plus the value of the silver alloyed therewith, less the expense of coining and refining.

In refining, that is the separation of the silver from the gold, it has been found expedient in practice to leave a certain small proportion of silver in the gold, since to extract the whole would be a much more expensive operation, and, for commercial purposes, not a necessary one.

The amount of silver which is retained in the gold is equal to 1–99 of the weight of the fine gold, in other words, the gold is refined to 990 fine.

It is usual to assume in calculating the value of bullion, that there are ten thousandths (.010) of base metal present.

The following examples will serve to explain the manner in which the net value of a deposit is obtained: Supposing we have a bar weighing 100 ozs.

gold 900 fine, value of the gold.............	$1860.46
9 ozs. pure silver, less 1–99 of 90 ozs. pure gold equals .909, which, deducted from 9 ozs. pure silver, equals 8.09 ozs. multiply this by the value of pure silver, $1.2929, and the value of the silver is..........................	10.46
Premium on silver in San Francisco Mints, 4 per cent................................	.42
Value of the gold and silver..................	$1871.34
Deduct charges: 8 cts. per oz. for refining, $8.00 ½ of 1 per cent for coining, $9.35...........	17.35
Net value in gold coin at San Francisco.......	$1853.99

In the preceding case the net value in coin is $6.47 less than the value stamped on the bar, which is that of the gold alone; it being the custom to look upon the silver as paying the expense of refining and coining, or in other words the conversion of the bullion into coin.

According to the proportion of the two metals the net value varies. In the example above given there was a loss. We may take another example in which the net value of the bar exceeds the stamped value of the gold, owing to the lower fineness of the latter and consequent larger proportion of silver.

100 ozs. gold, 800 fine, value of the gold......	$1653.73
19 ozs. pure silver, less 1-99 of 80 ozs. pure gold equals .808, which deducted from 19 ozs. pure silver, equals 18.19 ozs. multiply this by $1.2929, and the value of the silver is......	23.52
Premium on silver in San Francisco, 4 per cent	.94
Value of the gold and silver..................	$1678.21
Deduct charges: 8 cts. per. oz. for refining, $8.00 ½ of 1 per cent. for coining, $8.39..........	16.39
Net value in gold coin in San Francisco.......	$1661.82
Gain........$8.07.	

A simple method of calculating the value of the gold and silver in a bar is to reduce the proportion to fine gold and fine silver, and multiply by the value per oz. of pure gold and pure silver.

For example a bar 250 ounces, 850 fine of gold, 140 fine of silver.

250 x 850 = 212½ ozs. pure gold, @ 20.6718, =	$4392.75
250 x 140 = 35 ozs. pure silver, @ 1.2929, =	45.25
Value of gold and silver..............	$4438.00

The above calculations give the San Francisco Mint value of gold bars, that is the value of bars converted into coin in San Francisco.

Besides this there is the commercial value. Large quantities of unrefined bullion are required for exportation to Europe and the Eastern States, and the unparted gold may be said to vary in price like any other commodity according to the supply and demand.

When gold bars are cited at 900 par, it means that the price is $18 60 per ounce, i. e. the value of gold of the fineness of 900: and bars of a lower fineness would command a premium while those having a higher fineness would be subject to a discount.

For every degree of fineness above par, 1-100 of 1 per cent. is deducted, and for every degree of fineness below the par rate, 1-100 of 1 per cent. is added to the value of the bar.

Suppose 850 to be par. a bar 890 fine must be discounted 4-10 of 1 per cent, because it is deficient .040 in silver as compared with par rate. But if the bar be 810 fine, a premium of 4-10 of 1 per cent must be allowed, because it contains .040 of silver more than the par rate requires.

In England the coinage of money is done by the Government without any charge, and the United States Government has lately had under consideration the subject of either reducing the charge of ½ of 1 per cent, or of abolishing it altogether, with the view of stopping, as far as possible, the outflow of bullion, and increasing the coinage of the country. If such a measure should take effect, no doubt the export of bullion from the United States would be to some extent checked, and the calculations of the value of gold given above would require some modification.

Miscellaneous.

A cubic inch of fine gold weighs 10.1509 ounces, and is worth $209.84.

A cubic foot of the same is worth $362,600.

A cubic inch of United States Standard gold weighs 9.0989, and is worth $169,28.

A cubic foot of the same is worth $292,500.

The Troy ounce is equal to 480 grains.

The U. S. $20 piece weighs 516 grains.

The specific gravity of U. S. Standard gold is 17.3.

STATEMENT OF THE VALUE, PER OZ., OF GOLD DUST FROM VARIOUS LOCALITIES IN BRITISH COLUMBIA.

	Fineness.	Value of dust per oz.	Average Fineness	Average value of dust per oz.
Big Bend	892 to 9[illegible]	$17.37 to $18.58	914	$18.24
Burns Creek	895 to 92[illegible]	17.42 to 18.33	906	17.82
Cedar "	811 to 826	16.16 to 16.46	814	16.28
Grouse "	802 to 827	15.52 to 16.14	813	15.78
Keithley "	868 to 927	16.75 to 18.03	896	17.74
Kootenay	895 to 920	17.67 to 18.44	902	17.98
Last Chance Creek	905	18.10 to 18.13	905	18.11
Lightning "	877 to 898	17.48 to 17.93	888	17.80
Lillooet River	821 to 838	15.05 to 15.72	832	15.42
Lowhee Creek	888 to 925	17.21 to 18.37	906	17.83
Mosquito Gulch	906 to 915	17.88 to 18.32	910	18.17
Peace River	860 to 869	16.54 to 17.24	863	16.90
Rock Creek	847 to 862	16.78 to 17.16	854	17.00
Stouts Gulch	892 to 913	17.59 to 17.92	901	17.71
Van Winkle	893 to 923	17.58 to 18.24	908	17.91
Williams Creek (upper)	821 to 835	15.35 to 15.98	826	15.78
" " (lower)	847 to 869	16.60 to 17.31	854	16.91