

Bulletin No. 51

Sampling Series No. 1

University of Arizona
Bulletin

**Sampling and the Estimation
of Gold in a Placer Deposit**

BY
GEO. R. FANSETT



Entered as second class matter November 23, 1915, at the postoffice at Tucson, Arizona, under the Act of August 24, 1912. Issued weekly, September to May.

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FEBRUARY 20, 1917

SAMPLING AND THE ESTIMATION OF THE GOLD IN A PLACER DEPOSIT

BY GEO. R. FANSETT.

The sampling and the estimation of the gold present and recoverable play a very important part in the history and development of all placer deposits. For this reason everyone interested in placer mining should know the best methods of working this class of mineral deposit. The purpose of this bulletin is to indicate and describe to the miner and to the layman the best general methods used, so that they may understand and know how to do each and every part of the work, as well as to make the necessary calculations.

The work may be divided into three general subdivisions, namely: (1) The Sampling of the Deposit, (2) The Testing of the Samples, and (3) The Estimation of the Total Gold Present and the Gold Recoverable in the Deposit.

A placer is a deposit of mineral-bearing gravel, sand or soil. The commonest forms referred to are gold placers, tin placers, and platinum placers. The same method of procedure can be used in any kind of placer, but this bulletin particularly refers to gold placers, as they are the most common and of the most importance in the United States.

A sample is a collection of fragments or pieces from a deposit which contains exactly the same minerals in exactly the same proportions as they exist in the deposit. The act of collecting these pieces or fragments is called sampling.

The gold present is the amount of gold actually existing or present in the deposit. Gold is sold at the rate of \$20.67 per ounce Troy, but results from assayers are calculated at the rate of \$20 per ounce Troy. The ton used is the short ton of 2000 pounds avoirdupois. The value of silver fluctuates so that no definite value is given.

The gold recoverable is the amount of gold which can be extracted from the deposit by the use of any of the well known processes, such as a pan, sluice box, concentrator, centrifugal separator, dry washer, or any other process of ore dressing. There are always losses in this work, and for this reason the gold actually recovered is always less than is present in the deposit.

Sampling is slow work, and the greatest care is absolutely necessary and must be used in every detail of the work. Slipshod, careless work is absolutely out of the question, because if any one part of the work is not properly done, the collection of fragments obtained will not be a true sample of the deposit, and is not only valueless for the purpose intended, but will result in an incorrect estimate of the deposit.

RECORDS.

In the sampling of placers it is necessary to keep a good set of records, so that any questions which may arise can be correctly answered and definitely settled. For this purpose a topographical map, a sample book, and a diary are used to record all matters connected with the sampling of the deposit. These must be very carefully kept, as from one or all of them important points have to be decided.

If there arises a question in one's mind as to where to record a certain detail which seems to belong in two of the records, record it in both of them; and if it seems to apply to all of the records, record it in all of them, and do not consider it useless repetition—any matter worth recording is worth finding easily.

THE TOPOGRAPHICAL MAP.

A topographical map is made of the entire deposit as soon as a thorough preliminary examination has been completed. This map should be made to a scale large enough so that all details can be plainly marked. All distances for this map are measured on the horizontal. All elevations are calculated from a permanently fixed benchmark or datum.

When the location of a test pit or hole is decided upon and work started, the location, together with the number given to it, is marked on the map. Likewise, when a test hole or pit has reached bedrock, the elevation of the bedrock is recorded. On the map is also recorded, by their numbers, the location of each of the samples, and, after they have been assayed, the values obtained. This map is used to record everything of this nature concerning the deposit, and should be so well kept that its records, together with those kept in the sample book and in the diary, will answer all inquiries which may come up.

THE SAMPLE BOOK.

Supplementary to the topographical map a sample book should be kept. In this book all records and details pertaining specifically to

each sample are recorded, such as the name of the deposit, number of the sample, its location, the date when taken, kind of soil, assay returns, etc., etc.

A convenient form of sample book is one which has a page which is perforated near the far end so that this end part or tag can be easily torn off. The number given the sample is written on the part of the page which remains in the book and also on the detachable part. The sample book should be kept so that the information in it, together with the information on the topographical map and in the diary, will answer all possible questions which may come up regarding the deposit.

The form on following page represents one of the pages used in a sample book, but this form should be changed if necessary to meet the requirements of any particular job.

DIARY.

Together with above records a diary should be kept of the deposit. All matters of importance which are not naturally included among those recorded on the topographical map or in the sample book are taken care of in the diary. Such matters as the date when work started on a test pit, when and to what extent a certain pit caved, etc., should be recorded in the diary.

NUMBERING OF SAMPLES.

Each sample is given a different number, irrespective of its location, and by this number the sample is identified at all times. When the sample is taken the number is marked on the map at the proper location from which the sample was taken. The number is also marked on a page in the sample book and on the detachable part of the page or tag of the sample book, if paper tags from the sample book are used. When the sample has been cut down to the desired size it is put into a sample sack or container, together with the tag bearing its number.

TAGS.

Only one tag is put into each sack with each sample. The tags used for this purpose are made either of paper, soft wood, or metal. Paper tags are usually used except when the samples are very wet. These are usually the detachable part of the page referred to in connection with the sample book, but can also be any piece of paper with the proper number written on it. These are rolled up tight in the form of a lead pencil and have their ends well crimped. This is

THIS TAG IS PUT IN SACK WITH SAMPLE

THIS PART REMAINS IN SAMPLE BOOK		TAG	
NAME OF DEPOSIT		SAMPLE NO. _____	
HOLE NO. _____		SAMPLE NO. _____	
KIND & CONDITION OF DIRT _____			
WEIGHT OF DIRT PER CU. YD. _____			
ASSAYS		METALS	
GOLD.	VALUE		
OUNCES	PER CU YD.	PER CU YD.	
REMARKS			

BLANK PAGE FOR A SAMPLE BOOK

done so that they will not unroll and get soiled, thus keeping the writing legible.

Metallic tags having the number stamped on them are sometimes put into the sacks with the sample instead of the paper tags. Soft wooden tags with the numbers written on them with a hard lead pencil are also convenient. A hard pencil is recommended for writing the numbers on the wooden tags because it will cut into the wood and even if the lead is rubbed off the indentation will be left. This kind of tag is very useful with wet samples.

Where any other tag is used instead of the detachable tag of the sample book, all the information in regard to the sample should be recorded in the sample book in the same manner as was explained above.

SAMPLE SACKS.

Only new sample sacks should be used. Used sacks may contain values from the former samples which they have held, which values may get mixed with the sample, thus enriching or salting it. It is poor business to spend a large sum of money on a collection of fragments from a deposit, in obtaining the sample, testing, shipping, and other charges, if the collection is not a true sample of the deposit. New sacks cost only a few cents each and should always be used. If tin containers are used they must be thoroughly washed and cleansed before the sample is put into them.

SAMPLING PLACERS BY THE USE OF TEST PITS.

One of the common methods used for sampling placers is in the use of test pits. The method of procedure is the same whether the hole is a shaft, pit, drift, raise, or other form of excavation. The one point to be kept in mind is that *all* of the material excavated from the hole decided upon is the sample.

Test pits can be used to advantage where the ground is stable enough to stand up well, where the deposit is not too deep or where water does not interfere too much.

The sample from a test pit is considered by many engineers to be better, in some respects, than the samples taken from drill holes. This is based on several assumptions;

- (1) There is not the tendency for the values to concentrate in the lower level or bottom of the pit if the work is properly performed.
- (2) Sectional samples or samples for any particular depth at a given point can easily be taken.
- (3) The bulk of the sample from a test pit is much greater than that from a drill hole. For this reason, if small additions of values take place they will not affect the final result to so great an extent.

(4) In the test pit it is possible to see clearly the formations, and thus a better judgment of the deposit can be formed.

LOCATION AND NUMBER OF TEST PITS.

When test pits are used, great care and judgment should be exercised in locating the pits so as to get a fair final sample. Usually one pit for each two or three acres is sufficient. This is the number which was found ample in the sampling of several placers, but experience and judgment alone can decide this exceedingly important point for any particular placer deposit. As a general rule, the richer the deposit, the more pits are necessary. Also the greater number of pits are needed where the depth of the deposit is the greatest, as this represents the greater part of the tonnage. The sides or upper edges of the deposit should not be overlooked as these serve as indications as to whether the placer becomes richer or poorer as one works toward the higher benches.

FORM OF PIT.

The pits are usually rectangular in form, about three feet wide, and long enough so that a man can work to advantage. If the excavation is in the form of a drift, it must, of course, be high enough to work in comfortably. The sides should be as nearly perpendicular as possible. If the ground caves, it is necessary to timber it. If this happens, much care must be taken that none of the material outside of the section of the pit decided upon is included in the sample.

CAREFULNESS IN THE HANDLING OF THE SAMPLE.

The greatest care must be taken in handing the material. This is especially true after it has been taken out of the excavation. The safe way is to shovel or dump it directly onto a tight platform. If a platform is not available, a large sheet of steel or a large piece of thick canvas will answer the purpose. This is done so that no foreign material will get mixed with the sample. Since the bulk of the sample is usually much greater than is needed for the tests to be run (50 lbs. is usually more than is needed for panning and assaying), and too much to be handled conveniently, the next step is to cut or quarter it down to the size desired.

METHODS USED TO CUT DOWN THE SAMPLE.

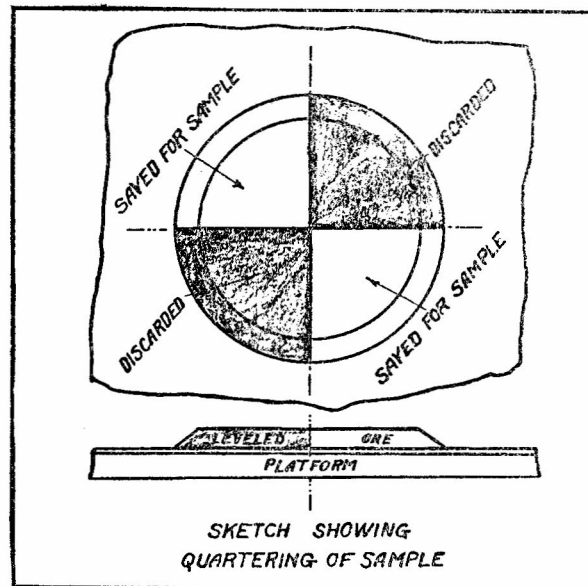
Where mechanical quartering machines are not available and the sample is over 800 pounds, all of the following methods can be used, in their order, to advantage in quartering down the sample. When the sample is less than 500 pounds and over 100 pounds, the Cornish method of quartering can be used. When the sample is less than 100 pound, the method using canvas or oilcloth is good.

CUTTING DOWN SAMPLE WHICH WEIGHS OVER 800 POUNDS.
SHOVEL METHOD.

The first of the cutting down to about 500 pounds can be done by the use of shovels. In this method every second shovelful is passed to another platform or a different part of the same platform, which has been well cleansed. The odd ones are discarded. This operation cuts the sample in half. If it is still much too large (over 800 pounds) the above operation is repeated until the sample gets to between 300 pounds and 800 pounds. After it is cut down to this size (about 500 pounds) it is better practice to use the Cornish or Coning method down to about 100 pounds.

CORNISH OR CONING METHOD OF QUARTERING.

When the sample is not much over 700 pounds this method is used conveniently. The last heap of material from the preceding work of cutting down is leveled to a circular form not over four inches deep,



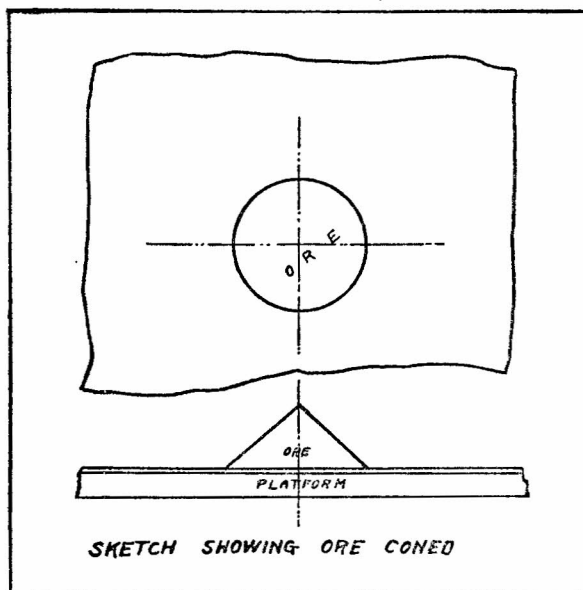
by the use of a hoe, flat-nosed shovel, or a similar tool. The next step is to cone it, which is done in the following manner: From the outside of this leveled heap, at points equally distant from each other, equal amounts are shoveled up and allowed to fall onto the center of the

leveled heap in such a manner that the material is evenly distributed on all sides of the cone which is formed. In this way only a portion of the heap is shoveled up is passing once around it, thus making an even distribution of the values.

After all of the material outside of the cone is piled up in this manner onto the cone, the material is removed to a different platform or a clean part of the same platform and leveled and coned again. This process is repeated until the material has been thoroughly mixed. When this has been accomplished it is then leveled again to a circular form not over four inches deep, and divided into equal quarters by cutting it along two diameters at right angles to each other. The two opposite quarters are discarded.

Much care must be taken in doing this work, as well as to clean thoroughly the parts of the platform where the discarded metal has

been in order to prevent salting. If the sample is still too large, more than 200 lbs., the two quarters which were left from the preceding operation are removed to a clean part of the platform where it is leveled, coned, and leveled again to a circular form and divided as before, the two



quarters being again discarded. This operation is repeated until the sample reaches about 100 pounds, when the following method should be used:

QUARTERING BY USE OF CANVAS OR TABLE OILCLOTH.

The final sample from the preceding work is shoveled onto a square piece of table oilcloth or canvas about 6 feet by 6 feet. After this is done the two opposite corners of the oilcloth are taken, one in each hand. While one of the corners is slowly lowered, the other is raised at the same rate, the lower part of the oilcloth always resting on the ground or platform. This motion rolls and mixes the sample. After this is well performed the first two corners are allowed to fall flat,

while the other two are taken in the same way. The sample is again rolled and mixed, but in the opposite direction to the first mixing. This is repeated several times until the sample is thoroughly mixed.

When this has been accomplished satisfactorily the canvas is spread out flat and the sample is leveled to a circular form as described before in the coning method. It is then divided into equal quarters by cutting it along two diameters at right angles to each other, as illustrated in figure (2). The two opposite quarters are discarded as in the coning method and the space where they were is thoroughly cleansed. If what remains is still too large the entire operation is repeated until the sample reaches the desired size. After thoroughly mixing it again the sample is put into a sack with the tag bearing its number for identifying it. It is then ready to be tested.

SECTIONAL SAMPLES.

These are samples taken at a given depth to indicate how the values run at that particular depth. They are usually taken from a section which has the same width completely around the pit or drift. When it is necessary to timber, these samples must be taken before the timber is put in place.

In the sample book record the number of the sample, the date when taken, the number of the pit, and all other data bearing on the sample. Measure down to the top of the section to be sampled from a fixed known elevation, such as the permanent ground level or a nail or stake solidly driven in at a definite elevation. Record this measurement in the sample book, together with the width of the section to be sampled.

The sample is the material which is picked off evenly from every part of this section. A sample pick, drill, or similar tool can be used. A box or other receptacle is held below so that all the material will be caught as it is broken off. A powder box answers this purpose very well. It is well to spread a piece of canvas on the ground below the place from which the sample is taken so as to catch any pieces that may not fall into the box. If the sample is too large it can be cut down, by one of the methods explained before, to the desired size. After being thoroughly mixed, the sample is put into the sack with the tag bearing the proper number, and is then ready to be tested.

DRILL SAMPLING.

Sampling by drilling is done either by the use of an augur drill, or by a churn drill outfit.

AUGUR DRILL METHOD.

The augur drill is a tool similar to that used in drilling post holes. The hole is made by the augur as it is turned, the material raised on the blades of the augur being the sample. It can only be used to advantage in soft ground which does not cave too badly, and only to a limited depth. The caving may be overcome by casing the hole.

Sampling by this method, where it can be used, is by far the cheapest and quickest of any method. It has the disadvantage, in some cases, of having the values concentrate at the bottom of the hole, from which it is next to impossible to extract them, thus tending to give an unfair sample.

The same care and experience in locating the holes to be drilled must be used in this method as in the location of the test pits. The records for sampling by this method are kept in the same manner as for test pits, and the same method for cutting down the samples can be used. After they have been cut down to the desired size they are well mixed, put into a sack with the tag bearing the proper number, and are ready to be tested. The testing of the samples and the method of calculation used will be treated later.

SAMPLING PLACERS BY THE USE OF A CHURN DRILL OUTFIT.

This is one of the very few methods which can be used to advantage when the deposit is deep, where the ground caves and where water interferes. For deep holes the cost per foot of hole drilled is low and the work usually progresses very rapidly.

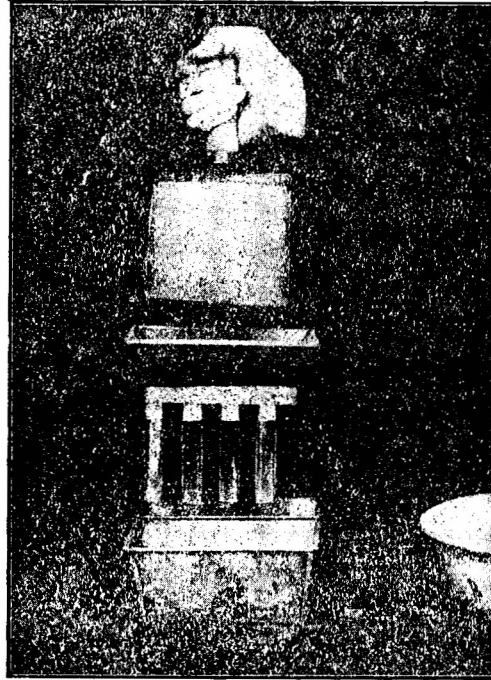
There is the disadvantage of the possible concentration of the values in the bottom of the hole, from which it is difficult to extract them. The values from around the sides of the hole may also be washed down into the sample and salt it. Sectional samples by this method are not considered to be very satisfactory. An expensive outfit is needed to do the work by this method, and unless much drilling is to be done it is found better to let the job to a reliable churn drill contractor who will furnish the rig, casing, and other supplies needed, as well as the skilled operators who are absolutely essential for doing the work satisfactorily. Where the ground caves or water interferes it is necessary to case the hole.

LOCATION OF THE HOLES TO BE DRILLED.

The same care and judgment should be taken in the locating of the points where the holes are to be drilled as is necessary in the location of test pits, and the same matters should be borne in mind when doing this work.

The same general method of procedure in mapping the deposit, taking and numbering the samples, and the care necessary in handling them, must be used for the churn drill work.

The material taken from the hole is usually crushed by the operation of the drill bit to a size smaller than a walnut. If, as in most



cases, the sample is much larger than is needed for testing, it can be cut down to the desired size by using the methods heretofore described. The sample from the churn drill hole seldom contains pieces much larger than a walnut and can be cut down very rapidly and accurately by the use of a Jones Sampler. This is an inexpensive apparatus which stands rough handling and is not very bulky. If the work is properly done, the final cut down sample is absolutely accurate and for this reason this machine can be used to advantage, providing the pieces in the sampler

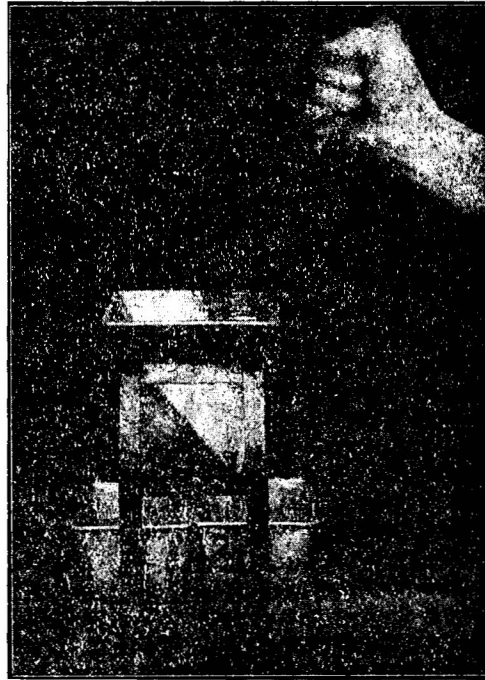
are not over one-half as big as the width of the slot in the sampler which is used. It is sometimes advisable to use one large sized sampler in the first part of the cutting down work, cutting down to the final size by using a smaller sampler, the slots of which are narrower than than in the first.

JONES SAMPLER.

On top, the Jones Sampler has a row of horizontal slots, all of which have the same length and width. From each one of the slots runs a chute, every second chute running in the same direction; that is, the outlet from the first chute and slot is opposite to the outlet from the second chute and slot. The material is shoveled slowly from a flat-nosed shovel or scoop transversely onto these slots, much

care being taken that they do not clog, the material distributed evenly by moving the shovel back and forth from one side to the other of the machine. The end of the shovel should be held about one inch above the slots of the sampler and in this way equal amounts of the sample will fall into each slot and run down and out of the chute under it.

A pan is placed under each row of chutes to catch the material. If the work is properly done, exactly one-half of the material will be caught in each of the pans, and each pan will contain the same values. One operation of the sampler cuts the sample in half. The material in one of the pans is saved for the sample, while that in the other is thrown away. If the sample is still too large, the above operation is repeated until it reaches the desired size. It is then put into its sack with the tag bearing the proper number, tied up, and is ready to be



tested.

TESTING THE SAMPLES—PURPOSES OF THE TESTING.

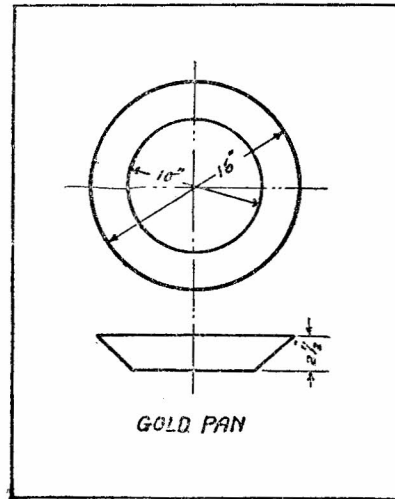
The amounts of valuable mineral present and recoverable are the most important points to be decided from the test. Supplementary to this are several other important matters which should be taken into consideration, such as the form in which gold occurs, whether fine, coarse, or flaky; whether clay is present, and to what extent, and all other points which will determine whether or not the deposit can be worked at a profit.

METHODS OF TESTING.

Samples from gold placers are tested by panning or by the use of the dry washer or concentrator, or by both. Only those deposits

where the dry washer can be used for working the deposit should be tested by the dry washer. These placers are only found in the deserts, where water for washing the ground is out of the question and where the ground is absolutely dry and free from clay. In all other placers the samples are usually tested by panning. After the panning tests prove satisfactory, tests on a large scale are usually made by using the method decided upon for doing the work.

For testing samples by panning the most important thing is a thoroughly experienced panner. The tools needed are good gold pans,



a measuring box, small pans, glass vials, a good pair of balances, and tags. The pans used are the regulation gold pans made from sheet iron and must be absolutely free from grease and rust. They are usually 16 inches in diameter on top, 10 inches in diameter on the bottom, and $2\frac{1}{2}$ inches high.

When the value of the gold obtained from the panning of one or more boxes of the dirt is known, it is an easy matter to calculate the value for a cubic foot or cubic yard of the dirt. The following example will illustrate this point:

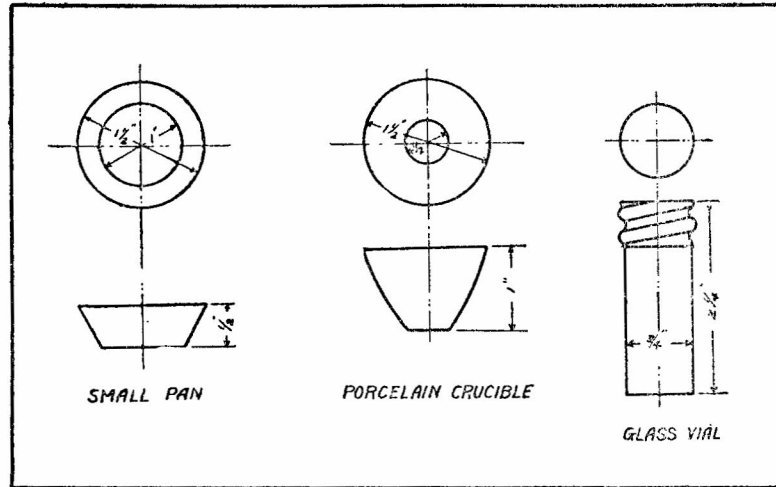
Suppose four boxes of dirt were panned, and from them were recovered \$0.02 of gold. (Gold figured at \$20 per ounce Troy.) Since there are 8 of the 6"x6"x6" boxes in one cubic foot, and there are 27 cubic feet in one cubic yard, the calculation for this case is the following:

$$\$0.02 \times 2 = \$0.04, \text{ the value per cu. ft.}$$

$$\$0.04 \times 27 = \$1.08, \text{ the value per cu. yd.}$$

Small pressed steel pans of about one and one-half inches in diameter on top, and one inch in diameter on the bottom, and one-half inch deep, made in the same shape as the gold pans, are very convenient for holding and drying the values after they have been concentrated in the gold pans. Small porcelain crucibles are also used for this purpose. Small stoppered glass vials are sometimes used, especially if the samples are to be transported to a distant place to be assayed and weighed.

The box used for measuring the dirt to be panned can be of any convenient size, the cubical contents of which are known. A very convenient size is a box whose inside dimensions are exactly 6 inches long, 6 inches wide, and 6 inches deep. This box, when filled smooth to the top, holds exactly one-eighth of a cubic foot, or one-two hundred and sixteenth part of a cubic yard.



A good set of balances with a standardized set of weights should be used for the weighing of the values recovered. It would be poor business to do all of the work well and then use an inaccurate set of balances to do this very important part of the work.

For identification purposes a tag must accompany each sample, and the concentrate from it. This tag always bears the number of the original sample from which it was taken and all additional data which applies to this part of the sample only, such as the number of boxes of dirt washed to obtain the concentrate, the method used in the testing, to obtain the sample, the condition and kind of the dirt, etc., etc.

WEIGHING OF THE SAMPLE.

After the sample is brought to the place where the testing is to be done, the measuring box is filled and weighed. The weight of the sample is the total weight minus the weight of the empty box or receptacle. Since the cubical content of the box is known, the weight of a cubic yard of the dirt can be calculated. This is needed in order to make the calculations from the gold per ton to the gold per cubic yard.

FIRE ASSAY OF PART OF THE SAMPLE.

At this point in the work a part of the original sample should be taken to be assayed by the fire method. This will give the exact mineral content of the sample, and from the value obtained the mineral present in the deposit can be calculated. The assay values are only used for calculations for the gold present, and are always given by assayers in ounces Troy—per ton (2000 pounds avoirdupois) of dirt, so that from this it is necessary to calculate the value per cubic yard of dirt.

PANNING.

One or more boxes of the dirt, as desired, are then dumped into a gold pan and panned, the amount of dirt from each sample which is panned to get each concentrate being recorded on its tag and in the sample book. This operation needs no explanation as those connected with placer mining are usually expert at this class of work. After all of the dirt is washed out and only the concentrates remain, there are two common methods of procedure for separating and collecting the gold from the black sand and other impurities which are always found in placers. One of the methods is to assay the concentrates by the fire method and weigh the resulting gold bead. This gives the amount of gold recovered from the amount of dirt panned, and the gold recoverable from a cubic yard can be easily calculated. This method is perhaps the quickest, most accurate, and cheapest of any. The other method is to add mercury or quicksilver to the concentrates and amalgamate the gold. The amalgam is then retorted. This operation removes the quicksilver and leaves the gold in the retort, from which it can be removed and weighed.

The values in this operation are for the gold recoverable from a cubic yard of the dirt, and are only used in the calculations for the gold recoverable. The practice of washing the black sand and other impurities in a horn is not recommended, as much of the value may be washed away and lost, thus giving an unfair result.

TESTING WITH THE DRY WASHER.

The same general method of procedure can be followed as above outlined, if the sample is to be tested by the dry washer in the actual testing. A sample of at least 100 pounds is needed.

From the above operations the value of the gold present and recoverable per cubic yard is determined for each sample. It is then necessary to determine the gold present and recoverable from the

entire deposit. This work requires the services of a man experienced in engineering calculations.

CALCULATIONS FOR THE VALUES OF THE DEPOSIT.

Two separate and distinct calculations should be made to determine these. One is for the gold actually present, and for this calculation the value as determined from the fire assay of the original sample before it was panned is used. The other calculation is for the gold recoverable, and in this calculation the values obtained after the samples have been panned are used.

GOLD PRESENT.

The gold present in a deposit is found in the following manner: The cubical volume of each section is calculated from the cross sections which are taken from the topographical map. The depths used are as found in the test pits, except they should be adjusted as determined by the contours of the bedrock.

The gold present for a section is the product of the cubical contents of the section multiplied by the gold value per cubic yard, as determined by the fire assay of the original sample taken from the test pit for that section before the sample was panned. The gold present in the entire deposit is the sum of gold present in all the sections.

GOLD RECOVERABLE.

The same method as described above is used for determining the cubical contents of each section. The gold recoverable for a section is the product of the cubical contents of the section multiplied by the gold value per cubic yard, as determined from the results obtained from the panning or dry washer tests.

After the above results have been obtained it is usually desirable to make a valuation of the deposit.

VALUATION.

The purpose of the valuation of a placer deposit is to find out the net profit obtainable after all charges have been deducted.

As there are no two placer deposits exactly alike, and as all differ so much from each other, it is impossible to give anything but a few suggestions as to what has to be taken into consideration in this matter. In addition to the estimation of the gold recoverable by the process of extraction decided upon, management, climate, labor, power, fuel, water, transportation, equipment, food supplies, interest

on investment, depreciation, government regulation, kind of government, etc., etc., are some of the many items which are important and must be taken into consideration in the calculations for making the valuation of any placer deposit. For the above reasons it seems advisable to have a thoroughly competent, reliable and experienced engineer supervise and be made responsible for the valuation of a placer deposit. The work will not only be correctly done, but the report on the deposit as submitted by the engineer will be accepted by everybody as authoritative.