PLACER ASSAYING - THE MECHANICS AND CHEMISTRY

By : Paul Hopkins

The mechanical steps of placer assaying are: Sampling, concentrating the values, separation of these values from the concentrates, and finally the weighing of the valuable component metals or minerals. On any project the several sample metals or minerals are placed in a small vial or bottle, labelled and stored for future reference and study. This practice is particularly recommended for anu placer gold project.

The sample program is outlined as being of various configurations density of sample locations and depth of sample by increments from surface to bedrock or bottom of probable exploitation. The particular configuration of location is orderly, yet not precise. Some guiding principles are given but these are not to be followed if the examination of the results indicate alternate pattern or patterns will give equal or better results for a total lower cost.

Narrow long deposits are usually evaluated by close spaced sample locations transverse to the longitudinal axis and appreciable distances between these transverse lines. Broad valley deposits such as where the valley width is 10 times the width of the stream at high water are usually drilled on a geometric pattern. The usual form is the approximate equalateral triangle. The spacing on both patterns, row or geometric should lend itself to closer spacing by the equal division of the distances between sample locations as the need may arise. The samples may be obtained by excavating pits, cutting samples from top to bottom upon exposed faces of banks or side hills, or by "drilling".

Each method has its own applications and limitations. The study of the various sampling methods and results predictable are discussed in many textbooks, field manuals, reference field manuals, reports and the brochures of companies supplying equipment or services to the placer mining industry. These sources include Peele's Mining

Engineer's Handbook, Well's Placer Examination, Principles and Practice, Keystone Drill Manual and Brochure, Londoñes Minas de Aluvia to name some sources.

The sample material from the sample location is measured as - to depth below ground level, volume in place, volume as recovered or loose material, and the lithology described. The sample is then washed using a gold pan, batea, rocker or cradle, or an acceptable mechanical unit to reduce the bulk to a very small part of the original - volume, yet still containing all the valuable metal or mineral of the original sample material. The particular equipment to reduce the - sample to this small concentrate volume will depend upon what is - available at the job location. The oldest method is hand washing all the sample using a gold pan or batea. Screening of the sample material through an appropriate size screen such as a gold pan with 6 or 7 millimeter diameter holes drilled in the bottom is a common practice. The screening reduces the total volume to be washed and gives the - first indication of the size of gravel and its distribution. A common field unit to speed this washing process is the rocker or cradle.

This unit requires only manpower and water. The unit consists of a short sluice box, with or without riffles, mounted on a wooden - base and which can be given a transverse rocking motion. The coarse - material, usually all over 6 or 7 millimeters, is washed and screened from the undersize and is discarded. The undersize is washed through the screen, dropping upon a canvas pocket, thence flowing over the end of this pocket to the sluice and to discharge. Water is usually - obtained by pouring buckets over the screen while agitating all the material by the rocking motion.

Occasionally, small sluices of about 15 centimeters width and 2 to 3 meters length are used.

Some mechanized units, motor driven and with an adequate water supply from a pump in a convenient water source, have been made. - These units have had varying success in the testing programs for - placer values by various company or engineering field parties. The most creditable of these units, based upon the comparison of results - of many units, is the Denver Equipment Division, Joy Manufacturing -

Company's "Gold Saver Unit". The lack of study of the accompanying literature and directions plus checking to adjust to local conditions have lead to poor results. This lack of study of the unit emphasises the need for the engineering group to test on sample material from the project area prior to starting the field sampling and evaluation work. The bulk sample of the metal or minerals obtained during this preliminary adjustement program is used during later work so the effort is not "lost".

The use of other units than the batea or pan produces a larger volume than desireable concentrate. This concentrate is then reduced to a more convenient smaller volume by washing using the batea or pan.

The concentrates from a finite location and depth are usually put into a small vial or bottle. One convenient size is about 23 mm. diameter and 90 mm. in length including the screw top. Boxes containing a convenient number of these vials are a part of the equipment to be assembled prior to field work. The writer has found units of 6, 24 and 48 are convenient sizes. Provision should be made to lock these boxes as the need may indicate.

The small volume of material from the panning operation is washed into the vial slowly and with the aid of a funnel. It is usually better to do this while working over a gold pan in case of spillage. A small wooden rack to hold the funnel and vial is most useful.

The color count of the number and sizes of gold pieces or other metals or minerals of value is made prior to the pouring of the concentrates into the vial. A check upon this count is made in the laboratory prior to the recovery of the contained values. These color counts are a very informative part of the field and laboratory work.

If the vial is one of a series of samples from surface to depth for a specific location, the color count is the basis for the location of the values in the section being examined.

Working with gold, the total accumulation of concentrates is further washed to reduce the volume, often double panned i.e., the

tailings are repanned for losses. The gold is amalgamed with mercury in the pan until all visible gold is picked up, or that which remains is rusty or otherwise resistant to the amalgamation process. This portion of the gold is estimated as to its percentage of all the gold in the concentrates and entered as part of the field notes. If one has many coarse pieces, these should be picked out, weighed made a part of the gold recovered for that location. The smaller material is treated with dilute nitric acid, abraded in the pan, or occasionally washed with a solucion of caustic soda to remove the oils and or iron rust coatings. The mercury is reintroduced and the remaining free gold is picked up by the amalgam. The writer suggests the use of glass chemical beakers of a convenient size or stainless steel gold pans of about 20 cm. diameter. These two materials are inert to the action of the nitric acid.

The amalgam is washed clean of any contaminants, thence put into a convenient size crucible as commonly found in chemical laboratories. The amalgam is covered to a convenient depth with dilute nitric acid, 3 normal as obtained by mixing in equal portions, distilled water and concentrated acid. Many engineers and field men use beakers for this start of dissolving the Mercury amalgam. The writer has found the crucibles are equally applicable and reduce the amount of supplies by the omission of the beakers from the supply list.

Heat may be supplied to the crucible or beaker to start the reaction and maintain its continuity. The chemical reaction is :

$$_2HNO_3 + Hg = Hg(NO_3)2 + H_2$$

The gold and its contaminants metals is essentially insoluble. Tests on the gold so treated indicate that only on the very small size pieces such about 100 microns diameter or less can any evidence of change be found. Even in these small sizes, the change is usually limited to a few parts per thousand. After all mercury is dissolved the gold residue is washed with pure water to remove the mercury nitrate solution. The gold in the crucible is placed upon a source of heat such as a plate of steel heated by a primus stove or electric

stove to dry. The mercury nitrate solution is poured into a convenient glass jar during the washing process. Copper is added to the jar resulting in the recovery of the mercury using the principle of the electromotive series of chemistry. The writer suggests using copper for this recovering of the mercury as it is easy to identify when most of the mercury has been recovered by the simple test of a small piece of copper wire being placed into the solution.

When the gold in the crucible is dry, the crucible and its gold are heated to about 500°F (285°C) marked by observing a dull red color to the gold and crucible.

A primus stove, kerosene plumbers torch or bottled propane connected to a small stove will all do the job. This heating vaporizes any remaining mercury nitrate and volatile contaminants.

The crucible is cooled. The gold is placed on the pan of a balance and weighed. A satisfactory balance will weight to the nearest milligram and can be estimated to 0.5 or 0.25 mg. by the user if so desired. After weighing, the gold is poured into small vials, labelled as to location and weight, thence filed for future study and reference.

These several vials are the proof of the values quoted in reports, hence should be kept in a secure place.