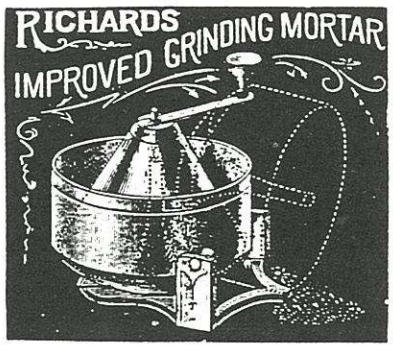

ASSAYING

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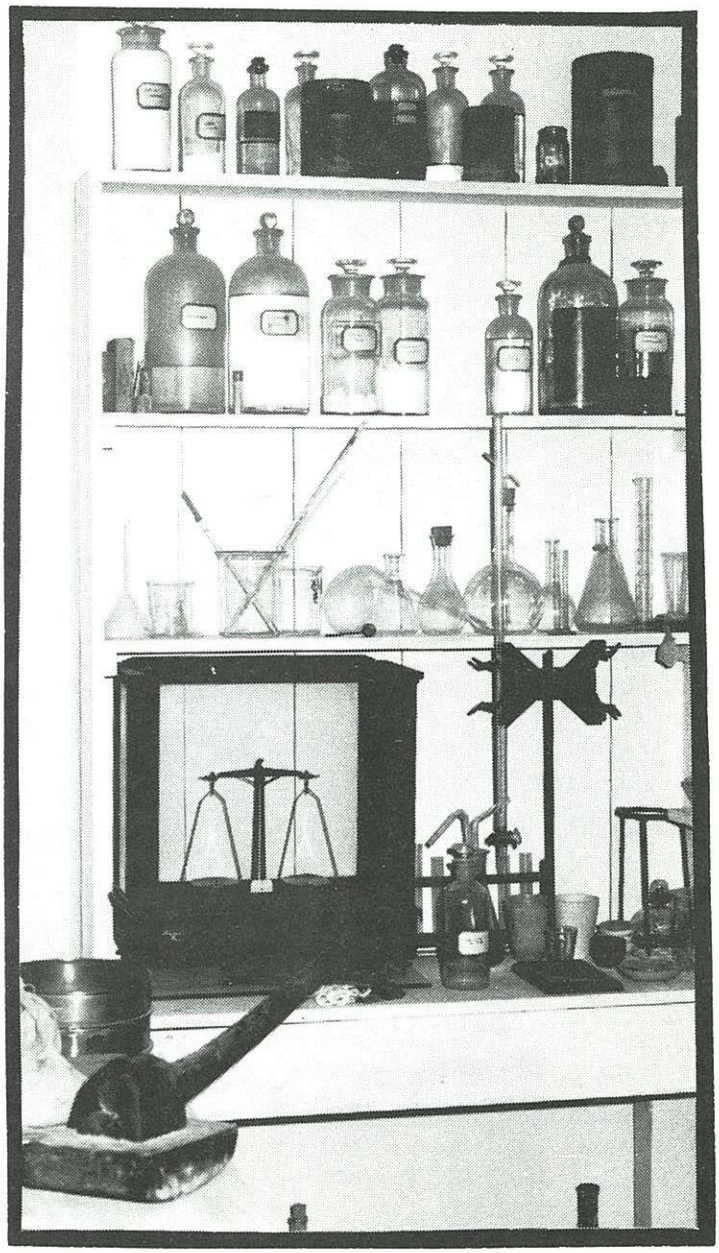
In Webster's dictionary assay is defined as follows: 1. in metallurgy, the determination of the quantity of any particular metal in an ore or alloy; especially, the determination of the quantity of gold or silver in coin or bullion.

While the most common definitions of the word assay do revolve around the determination of gold or silver in ore or alloys, assay is itself a much broader subject which involves the quantitative analysis of chemical substances both organic and inorganic. The primary interest of this article (likely quite obviously) is the assay of metalliferous ores. Because even this is a broad subject which has filled a large number of full-size books, I am here going to explore some of the highlights of fire assay by the scorification process in more ordinary gold bearing ores.

The miner must collect some of the ore in question from his prospect or mine. This is submitted to the assayer, often in an ore bag. The bags for ore assay vary somewhat and while they are occasionally made of paper, most ore bags found in collections are made of cloth or canvass and have the name of the assayer marked on them. Some ore bags have tags on them which make it much easier to keep track of the information specific to the ore being tested. Such as: the mine it is from, what part of the ore body it was removed from and when it was taken. This is especially important to larger mining operations which may constantly be taking samples of ore for assay. Once the ore has been submitted to the assayer for analysis, the actual steps of the assay may begin.

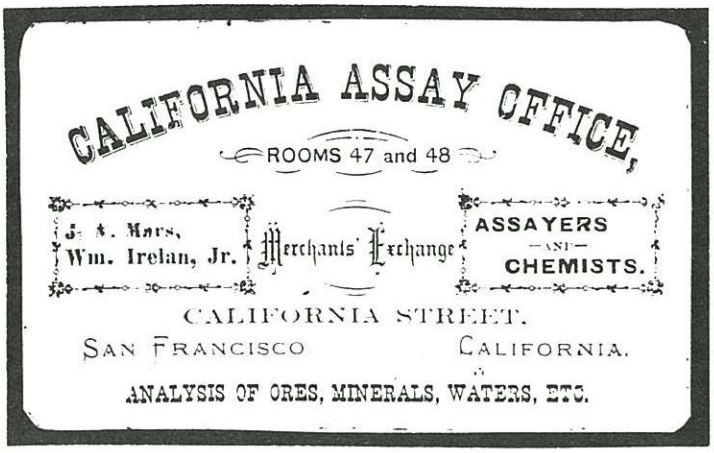
It is appropriate to interject here that in some mining areas the number of persons



A photograph of assay equipment and chemicals typically found in an assay office. Items include an analytical scale, a mullar, classifying screens, chemicals and glassware.

engaging in the assay business appears to be quite large. Just check the advertisements in older newspapers in mining towns, and you will see how many there often were. The situation is often a result of a successful mine having high grade ore with visible gold it. The key word here is "high grade." Many collectors are familiar with the practice of high grading among miners, and have seen some of the deviously clever miners' candleholders designed to assist them in this practice. Well, it is quite one thing to collect gold out of the seam in the mine and hide it with mud or wax in the handle of your candleholder, but once on the surface, you must now convert your ill gotten gold into cash. Here is where the overabundance of assayers in mining towns becomes clear. In complicity with the high grading miners, the assayers would buy the high grade from them and refine it in their shops. Of course it was all "legal" because miners bringing in high grade claimed to be prospecting on the side, so this was ore from their own small claims. Needless to say, the mine operators were quite aware of high grading and the collusion of assayers in it, and this created plenty of friction.

Initially, the ore sample must be reduced to a powder so that it can be sampled and tested. This powder is often called "pulp" and in some catalogs, the scales to weigh it are called "pulp scales." The assayer would start by running the ore through a crusher or simply smashing it with a sledge hammer. With many crushers, the fineness of the output was adjustable. The ore was still not sufficiently fine after initial crushing, so the assayer would then put it onto a "buck board" for further pulverization under the muller which rubs the material into a finer state with a sliding motion. Harder ores are made finer sometimes using a device called a "rocker" which uses a heavier weight upon the ore being pulverized. Assayers doing a smaller volume of work might use an iron mortar and pestle, although it requires considerably more effort.



This is the business card of an assayer

As the pulverization of the ore sample proceeds, the assayer mixes and then divides the sample into smaller and smaller quantities until he has reduced the amount of the sample to the size which he will actually process. This can be done manually or by using devices designed to assist in the sampling process. This is done to assure a uniformity within the sample and to increase the accuracy of the assay to be performed.

When the sample has been sufficiently pulverized, it must be run through sieves of the appropriate size. That material which does not pass through must be further ground until the entire sample will pass through the sieve. What has then passed through the sieves must be carefully mixed and then stored in a marked container. The contents of these containers should not be shaken or agitated as this can cause the materials to begin stratifying according to their masses and upset the accuracy of the process.

From various parts of the container, selected portions of the sample are taken and weighed. This step in the process uses scales that, while they must be accurate, are not anything more than analytical scales which could have been used to weigh anything in a laboratory. Many scales found marked "gold scales" at antique shows and flea markets are of this type. The most particular characteristic of these scales is that their pans (the place where items are actually weighed) are usually 1 $^{1}/_{2}$ inches or more in diameter. They are not specifically "gold scales."

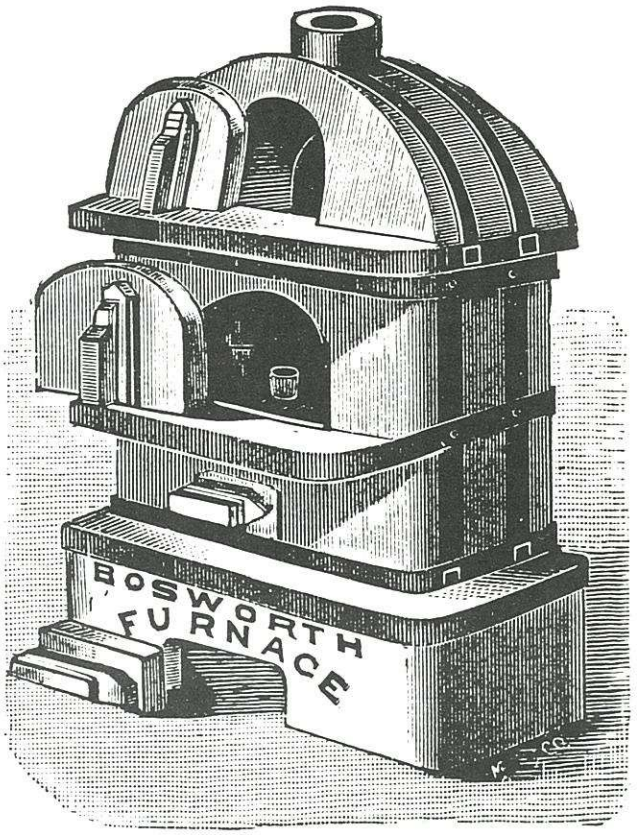
The weighed sample is then placed in a scorifier which is a dish that can sustain the heat of the assayers oven. Along with the sample are included litharge (a form of lead) and various chemicals which will assist in allowing the metals in the sample to separate from the slag.

This is roasted in the assayer's oven until the melted slag completely covers the lead bead that forms in the scorifier.

The sample in the scorifier is next poured into the cup of the scorification mould. Here it is allowed to remain until it is stone cold. Once cold, the sample is removed from the mould. It is cone shaped with the metal at the apex of the cone and the slag forming the bottom. The metal part or lead button is detached from the slag. This button may then be hammered into a cube shape with no sharp corners.

The "button" is placed into a cupel of appropriate size. Cupels are comprised of a material called bone ash. While cupels were available from supply houses, some assayers made their own. This cupel is placed into the assayer's furnace. When it has come up to heat, the button is place in the cupel. In this process, lead and other impurities within the button are both oxidized and driven into the material of the cupel itself. A good cupel is capable of absorbing its own weight in litharge (the lead in the sample). Collectors may note that used cupels are sometimes quite heavy for their size. That is due to the lead that they have absorbed. The metal in the cupel melts and will be observed to become smaller as the process proceeds. Towards the end of the process, the surface tension of the metal will draw it into the shape of a bead, it will appear to be in rapid motion and at the moment the process is complete, an optical energy release will sometimes be visible as a "flash" or "blick." At this point, the cupelation is complete and the cupel with its bead may be removed from the oven.

Now the bead is removed from the cupel. The composition of the bead should now be gold and silver. The bead is weighed in a type of scale made specifically for this task in mineral assay. It is called a button scale, and may truly be considered to be a gold scale. The most obvious characteristic of a button scale is that while the entire scale is as large as an analytical scale, it has remarkably tiny pans (the place where the button is weighed). These pans are less than an inch in diameter, and always concaved. There is a reason for this. The item



An example of an assayer's oven.

being weighed is small, in fact, the "button" is sometimes so small that it is difficult to see. Button scales, because they are measuring something so small, must also be very accurate and are thus always enclosed, while analytical or pulp scales do not always require enclosure. Weighing the bead has shown how much metal is there, but has not told how much is gold and how much is silver.

The next step of assaying is called "parting." In this step, the gold and silver are separated from each other by solution. The weighed bead is flattened, placed in a porcelain capsule and treated with a solution of water and nitric acid. Once reaction begins, the capsule is warmed. Silver in the bead forms a solution of silver nitrate which is carefully washed away until only the gold, if any, remains. This is gently dried in the porcelain capsule and then removed.

The final sample of gold is again weighed in the button balance, unless it is too small to be weighed, in which case it is simply described as

a "trace" or "color." From the weight of this bead the assayer will then calculate the gold and silver ore value per ton of ore. The assayer may use a special set of assay ton weights when weighing the gold to more easily calculate the assay value of the ore.

The realm of collectible artifacts in the field of assaying can become quite large. The one thing to watch for in these types of items is their vintage or age. Assaying is a process that is still being done for mining, and assaying supplies are still available new. Among some of the marked artifacts, gold and silver moulds with such names on them as Taylor, Denver Fire Clay Company, The Braun Company (still in existence) are especially desirable.

Among scales, while antique dealers tend to call all scales "gold scales," the only true gold scales--and therefore the most desirable--are the button balances with the tiny pans. The next most interesting scale, but not always certain to have been used in assaying, are the analytical balances used for weighing the "pulp."

Cupels and crucibles, while neither expensive nor terribly valuable, make any display on mining more interesting. Crucibles are seen most often in the round design, but the triangular style can be found also. Cupels come in a variety of sizes, and I like to have some that are used and some that are not in my displays. Speaking of cupels, don't forget the iron cupel trays. Most have a number inside each depression to keep the cupels organized. The trays are easier to find than the handles, which clip onto them. With respect to crucibles, special tongs just for grasping crucibles are not terribly hard to find.

The variety of scorification moulds to be found seems at times to be endless. Just about the time I think that I've seen all the designs that there are, I see another different design. Some have wooden handles, but on others, the handle is just another molded part of a one piece iron body. One thing that is certain however, if it is a scorification mould, the cavities of the moulds are all the shape of inverted, sharply pointed pyramids.

Mullars of any type are not seen often and should be seriously examined when found. The most likely small crushing device which you will see is the rotary muller, which is usually cranked around and around with a handle to pulverize the ore. The buck board type muller, which uses an axe handle, is found less often. Also seen fairly rarely are the small ball mill and jaw type crushers.

Iron mortars and pestles come in a wide variety of sizes. The smallest that I have seen would drop into a shirt pocket and usually are from portable assay kits. The largest mortars that I have seen are heavy enough to present awkwardness in lifting with pestles like small, but heavy, iron clubs that can exceed seventeen inches in length.

Retorts are an occasionally seen device that was used by assayers--and also miners--to separate mercury from gold to recover the (expensive even in those days) mercury. It can be thought of as a mercury distillation apparatus. The mercury/gold amalgam is heated until the mercury vaporizes and escapes through the tube. From the tube the mercury is cooled, condensed and collected for future use. Only the metal gold remains in the retort. I have seen retorts that would just about fit into a shirt pocket--obviously for portable assay or refining kits--and also retorts of much larger sizes weighing fifteen pounds or more.

While many chemicals are used by the assayer, one of the few used just in assaying is litharge. Litharge is a lead compound and thus very heavy (having a high specific gravity). In my own collection I have a bag that, while not being physically very large, is marked as containing 50 pounds of litharge. The litharge box in my collection is larger than the bag, but for its size is very heavy--even when empty. It is heavily reinforced so that it would not break apart during shipment.

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