ADMMR

**Arizona Department of Mines and Mineral Resources**
1502 West Washington, Phoenix, AZ 85007 Phone (602) 771-1600
1-800-446-4259 in Arizona FAX (602) 771-1616 www.mines.az.gov

# ASSAYERS AND ASSAY OFFICES IN ARIZONA

## Circular No. 91, Revised October 2009

*The Department is often asked how or where to obtain an analysis of samples. The listed companies have informed this department that they do assaying for the general public. All assays are performed by or under the supervision of an assayer registered by the State of Arizona Board of Technical Registration, as required by law. For information on the registration status of specific assayers contact the Arizona Board of Technical Registration, 1110 W. Washington, Suite 240, Phoenix, Arizona 85007, phone 602-364-4930, www.btr.state.az.us On page 2 of this circular is a discussion of the fire assaying process that concludes with some purported problems with fire assays. Contact the Department for additional information on mining, prospecting and mineral resources in Arizona.*

## ARIZONA ASSAY OFFICES,

*AA = Atomic Absorption Analysis, ICP = Inductively Coupled Plasma Emission Spectrometry*

### MESA

**CRM Industries**
Craig McGhan, Registered Assayer
462 S. Gilbert Road, #788
Mesa, AZ 85204
Telephone: 480-982-4182
Services: Fire assay, AA, wet chemistry, amalgamation, placer gold

### PRESCOTT

**Copper State Analytical Labs Inc.**
D. A. Shah, Registered Assayer
1050 Spire Dr. Unit I
Prescott, AZ 86305
Telephone: 928-443-5227
www.prescottlab.com
Services: Fire assay, precious metal analysis, geochemical analysis, base metals, AA, ICP

### TUCSON

**Jacobs Assay 1880**
Mike Jacobs, Registered Assayer
1435 South 10th Avenue
Tucson, AZ 85713
Telephone: 520-622-0813
www.metconresearch.com
Services: Fire assay, precious metal analysis, geochemical analysis, base metals, ICP packages

**Mountain States Research & Development Inc.**
Walter Leming, Registered Assayer
13801 E. Benson, #A
Vail, AZ 85641
Telephone: 520-762-5364
www.msrdi.com
Services: Fire assay, AA, ICP, precious metals, base metals, umpire analysis

**Skyline Assayers & Laboratories**
Bernard Dunn, Assayer, General Manager
William L. Lehmbeck, Registered Assayer
James A. Martin, Registered Assayer
1775 W. Sahuaro Dr., Tucson, AZ 85745
P O Box 85670, Tucson, AZ 85754
Telephone: 520-622-4836
www.skylinelab.com
Services: Fire assay, geochemical analysis, general metal assay

### YUMA

**Millenium Industrial Co.**
**Western American and Chemical Consultants**
Cana D'Avela, Registered Assayer
201 West 17th St., Suite 1
Yuma, Az 85364
602-721-6849
Services: Fire assay, analytical chemistry

# THE FIRE ASSAYING PROCESS

*The Department highly recommends analysis of samples by the fire assay method to determine precious metal content. Fire assaying, in use for thousands of years, still stands the test of time. The following summary is taken from "Assaying," by Jim Steinberg in Mining Artifact Collector. The article was written from a historical viewpoint, but the process is the same as the fire assaying of today except for the use of electronic balances, mechanical pulverizers, and so forth.*

In Webster's dictionary 'assay' is defined as follows: "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 that involves the quantitative analysis of chemical substances both organic and inorganic. The primary interest of this article is the assay of metalliferous ores. Because even this is a broad subject that has filled a large number of books, the highlights of fire assay by the scorification process in gold bearing samples are going to be summarized here.

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

As the pulverization of the ore sample proceeds, the assayer mixes and then divides the sample into smaller and smaller portions until he has reduced the amount of the sample to the size that 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 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. Material that does not pass through must be further ground until the entire sample will pass through the sieve. What has passed through the sieves must then 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.

Cupels

From various parts of the container, selected portions of the sample are taken and weighed. The weighed sample is then placed in a scorifier, a dish that can sustain the heat of the assayers oven. Along with the sample litharge (a form of lead), various chemicals that will assist in allowing the metals in the sample to separate from the slag are included.
This mixture is roasted in the assayer's oven until the melted slag completely covers the lead bead that forms in the scorifier.

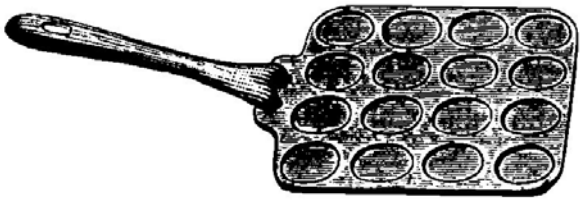
The sample in the scorifier is next poured into the cup of the scorification mold. Here it is allowed to remain until it is cold. Once cold, the sample is removed from the mold. It is cone-shaped, with the metal at the apex of the cone and the slag forming the bottom. The metal part, or lead button,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

The button is placed into a cupel of appropriate size that is then placed in the furnace. Cupels are comprised of a material called bone ash. When it has come up to heat, the button is placed 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). 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. The bead 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 called a button scale. 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.

Cupel Tray



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 that is carefully washed away until only the gold, if any, remains. This is gently dried in the porcelain capsule and then removed.

Scale

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.

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**In summary fire assaying is a 3-step process:**
1. **Fusion** - The sample is mixed with flux, then heated to 1850° F. A slag containing the unwanted elements and a lead button containing the gold and silver are formed.
2. **Cupeling** - The lead button is heated and oxidized in a bone ash cupel that adsorbs the lead oxide, leaving a precious metal bead in the cupel.
3. **Parting and Weighing** - In this part of the process, the gold is separated from the silver. Two weighing steps are involved.

## Discussion of Fire Assaying's Purported Problems

Fire assaying is a series of chemical steps that takes advantage of the precious metal's chemical behavior. Those who claim they have non-fire assayable gold are saying they have a substance that chemically does not behave like gold. Arguments used to explain why fire assay is not applicable to their "Colloidal" or "Micron" gold generally fall into one of the three categories discussed below.

***"The particles are so small they vaporize and so are not in the button."***

1850° is below the melting point of gold. Even if the temperature goes above 1850° the vapor pressure of gold is small, so very little is lost. H2O, for example, has vapor pressure 6 orders of magnitude higher.

***"Small particles of gold float on the surface of water so they float on the slag."***

This ignores the process that goes on. It is not dependent on gravity. The PbO2, now Pb, dissolves the gold. It is the Pb that collects at the bottom of the crucible.

***"Interfering elements mask the gold."***

The London Mint ran an assay of 1000 mg tellurium, 1 g Au, 25 g Pb and skipped the fusion step! Even so the "worst" they could do was to lose about half the gold. These conditions are highly unlikely in a rock sample. What about the platinum group metals? These, if present, report with the gold in the bead.

## *Conclusion*

Fire assaying, in use for thousands of years, still stands the test of time.

**BLM Assay Laboratory Report**

Due to documented Public Land administration problems caused by inaccurate or nonreproducible precious metal assays, the Bureau of Land Management's (BLM) Washington Office assigned the National Training Center in Phoenix to develop and implement a scientific survey of assay laboratory results.

View the BLM Assay Laboratory Report at http://mines.az.gov/Info/BLMassaylabsreport.html