SCIENTIFIC WORKSHOP REINTERPRETATION, Part 2

1. Alchemy-Assay Workshops **Notes by ECK 2/21/2022**

Sources: Visual information drawn from ten contemporary illustrations (see separate file) from early 16C to later 17C: *alchemists distilling*, print by Stradamus, c. 1550; *Smelting silver* in Agricola, *De Re Metallica xii*; *assay needles, DRM vii*; reconstructed 16C alchemical room by Otakar Zachar, National Technical Museum, Prague; *Der Schrifftgiesser* in Jost Amman, *Ständebuch* [Book of Trades], 1568 edition ; early 17C print of alchemy workshop w symbols; *Alchemist's workshop*, Hans Weiditz (d.1537) woodcut; *Alchemist*, Peter Breugel (d.1569) painting; *Alchemist*, David Teniers I (d.1649) painting; *Alchemist*, David Teniers II (d.1690) painting.

Structures*:* wooden, brick, walls, or framed w w&d or stone infill. Most are part of larger building. One detached w 1 and 2 half sides open (open side has corner brace) roofed w shingle? and open vent, no ceiling. Plaster or dirt floor common, w one tile or brick. Corner cupboard, raised. Window large (artist shows exterior scene), single or double, glazed. Interior shutter for unglazed window.

Furnaces*: Assay type* – from Agricola, tabletop, portable, rectangular and round. Both have raised bases and oval mouths. Top opening not shown, but probably round.

Distilling type - cylindrical w single large round top hole or raised center hole w added multiple small round holes. Metal, on 4 legs, w firepan beneath. Other w arched fire mouth by base. Another w rectangular brick foundation and arched fire mouth or w square fire mouth w/out door and have several top holes at different levels. All use wood.

Other squat or tall brick cylinders w central hole and low rectangular fire mouths w iron doors. Charcoal on large brass? dish.

Metal (silver) refining – squat cylindrical of iron? plates, with chains to beams above. Rectangular fire mouths at chest height. Wood fired.

Alchemical – Iron plate-and-hoop barrel shape w arched fire mouth above base. Resting on low platform. Hole is entire top surface. Could be imaginative.

Another is a waist-high arched wall furnace. No sign of fire mouth; fire directly on surface? Similar one of brick is knee-level but has a broad fire mouth used only for storing pots. Fire is on surface with wood used. Another image has a similar waste high fireplace, w unused arch below. Fire on surface with bellows and crucible. Also on surface is small box furnace w top hole and alembic. Further example of waist-high wall furnace has burning wood in base arch and crucibles? being worked on surface under arch.

Fittings*:* Stump, benches, tables; stumps, table, wheelbarrow; shelf; stump, tables, tool rack; barrel-chair, table, stool, shelf; table, shelves, wood block seat; tripod stool, wood block, door-on-barrel table; bench w pillow.

Tools: hand bellows, large fixed furnace bellows, tongs, triangular crucibles, glass beakers/bottles, hanging cresset lamp, brass pot w spigot, hourglass w hexagon (and round?) bases, mortar & pestle (a large one w rope attached to suspended bend rod), flat tongs, iron pan w rim & thumb-handle, brass pan w rim, brass cauldron w three iron long legs, metal 'stirrers'? of spearhead shape, thin wooden stirring rod, stump on working surface, baskets, pipkins, delft pharmaceutical jars with paper/string covers, paper sachets, chisels, file, two-head and fork-end hammers, anvil, handpick, long-handled hinged tongs, scissors/clippers, awls, gouge, wood handled curved knife, folding knife/razor?, strike-a-light, long wooden spoon, balance scales w weights, assay touchstone and 'needles' on ring, metal ladle, large rotary press for crushing ore, a handled wooden 'tablet' w vertical slot to look at assay.

Note: no example of suspended bellows, though Agricola shows one, a 'double bellows' in a frame.

Containers leather & cloth pouches w drawstring, case bottle, cloth sack labeled 'dried herbs,' wooden tub, stoneware jug, baluster jar, one with handle (for butter), round wooden boxes w lids, ceramic jars and pots, wicker-covered glass? bottles w cloth as stoppers.

2. Excavated Objects and Sources

Excavated items 1991-93, **SEAC accession group 907.**
(from FORA O&A, Appendix 11 – Artifact Inventory)
Palette Cupel. #285, 286 – 31B
White stuff. #71 - 8N, #72 - 8G
Iron scale. #55 – 8D, #66 – 31B
Iron flake #46 - 41J, #49 – 8D, #58 – 8D, #59, 60 – 8F
Lead. #2. 2A? (missing). Second list: 41F, 41J (seal); In field notes, not on list, melted lead, 25 backfill.
Lead seal Debennies (Bennie's?). #128 – 40D. Not from fort? But see abo sherd below.
Copper chunk. #95 – 40G.
Kaolin?. #106 – 34F
Abo sherd w cucurbit. #127 – 41J
Coal. #174 – 2A, #177 – 49F, #6, #178 – 48C#20, #179 – 49L#4, #180 – 49B#9, #181 – 40G#37.
Coal and clinkers. #168 – 49L, #169 – 8D, #170 - 31B, #171 – 40M, #172 – 8G#42, #173 – 12C.
Slag. #182 – 8F NN, #186 – 8D#18.
Antimony. #17 - 12C.

Harrington 1965 Excavation notes,
(from FORA O&A, p. 491):
Subfeature 65-1F, [slot trench or] log mold 'appears to turn at rt. angles in new test trench. Tar deposit (F-65-6) lies at edge of mold, near outside corner. Relationship cannot be determined at yet.
(O&A, p.493): Feature 65-6: Oblong hole with pitch or tar in bottom.

(O&A, p. 494): F-65-6 A similar deposit was found near the surface. It contained the identical material of pitch or tar. Imbedded in it was a piece of thin iron (possible from a "tin pail") which does not appear to be old. This feature, [unreadable] and the higher deposit must be relatively recent.

SILVER

Atocha mercury 1622. "Mercury on a Galleon," Corey Malcom, *The Navigator: Newsletter of the Mel Fisher Maritime Heritage Society*, Vol.22, No.2, March/April, 2006

The discovery of 50.26 grams (3.71cc) of mercury from the wreckage of the galleon Nuestra Señora de Atocha evokes a sense of the scientific practices that prevailed in 1622, especially as they related to mining and medicine. In addition to the small amount of mercury, clumps of mercury amalgam, have been found at the site.

This process, which had been exported to the American colonies in the 1550's by a Sevillian cleric named Bartolomé de Medina, and adapted to the large-scale demands of the New World's mining industries, proved to be revolutionary. Medina had been working on ways to improve on metal smelting, when his efforts caught the notice of a helpful German alchemist. This man showed Medina a way of combining mercury with ore to extract pure metals. He told him:

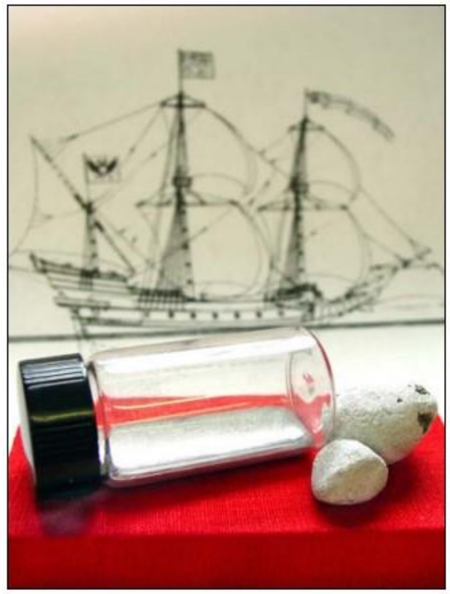
"Grind the ore fine. Steep it in strong brine. Add mercury and mix thoroughly. Repeat mixing daily for several weeks. Every day take a pinch of ore mud and examine the mercury. See? It is bright and glistening. As time passes, it should darken as silver minerals are decomposed by salt and the silver forms an alloy with mercury. Amalgam is pasty. Wash out the spent ore in water. Retort residual amalgam; mercury is driven off and silver remains."1

1 "Bartolomé de Medina: The Patio Process and the 16th Century Silver Crisis" by Alan Probert in *Journal of the West*, Vol.8, No.1, January, 1969. A similar process had earlier been outlined in Vannoccio Biringuccio's *La Pirotechnica* of 1540.

When this process was applied to the ores of Mexico and Peru, the efficiency of metal extraction increased by 500%.

Mercury has the unusual property of dissolving many metals, especially gold, silver and tin. This makes it especially useful in recovering them from ores by crushing the raw material, and mixing it with mercury and salt until the metals combine into a pasty mixture. The remaining amalgam can be squeezed or heated until the mercury is driven off, leaving the desired precious metal behind. This process is quite ingenious in its simplicity, requiring only copious amounts of mercury, brine, copper sulfide, and labor. The unfortunate aspect of it is the toxicity of mercury, which destroyed the well-being of many who worked with it, and the long-term pollution it leaves behind.

Two small clumps of mercury amalgam recovered from the wreck of the *Atocha* in 1984. They have a granulated texture and are quite soft.



Mercury clearly had a role on Spanish colonial ships, but what was it?

ıis mercury from the 1622 *tierre firme* galleon *Nuestra Señora de Atocha* was recovered by Salvors, Inc from the northern end of the wreck site in 2002 and donated to the Mel Fisher Maritime Heritage Society.

P. 9, note 13 Archeological research in the last two decades seems to indicate that boneash cupels and hearths were actually uncommon prior to the 16th century, and that a variety of porous ceramics were used instead for small volume cupellation. This seems a little problematic to me in light of Theophilus's instructions to use ashes for cupellation, but try and tell an archeologist that… (Bayley, 1995)

“Silver refining: production, recycling and assaying.” J Bayley, K Eckstein. *Archaeological Sciences 1995. Proceedings of a conference on the application of scientific techniques to the study of archaeology*, Oxford. 1997 Oxbow Monograph 64, pp.107 – 111.

p. 10 For an assay furnace, a muffle is traditionally arched like a miniature portable quonset hut, which can be inserted or taken out of the furnace as needed. Its sole function is to prevent the carbon from the fuel source from reacting with the contents of the muffle. A fixed furnace which is heated by, but isolated from the fuel source, is usually referred to as a cupellation or muffle furnace Most of the cupellation for this study happened inside the muffle furnaces at Sierra College.

Once the furnace is up to temperature (~900°C), the argentiferrous lead is placed in a cupel or on the cupellation hearth. Since lead is a base metal, in the presence of heat and oxygen (but not carbon), it will oxidize to red or yellow litharge. This litharge will be in the liquid state due to the elevated temperature of the furnace, and will be adsorbed by the porous cupel or hearth. The temperatures needed to melt lead and litharge

P. 11 are not sufficient to melt silver. When all the lead is converted to PbO and adsorbed by the cupel, the only solid left in the cupel or on the cupellation hearth is the silver. The mining term for the round bit of precious metal left at the end of cupellation is a doré.

COPPER

From askinglot.com
Some copper sulfides are economically important ores. Prominent copper sulfide minerals include Cu_2S (**chalcocite**) and CuS (**covellite**). In the mining industry, the minerals **bornite** or **chalcopyrite**, which consist of mixed copper-**iron** sulfides, are often referred to as "copper sulfides".

Keeping this in consideration, how is copper extracted from sulphide ore?
Copper is a metal that is present low in the reactivity series. It mainly occurs in nature in the form of **sulphide ore** which can be converted into the corresponding oxide simply by heating in the absence of air, a process known as roasting. The obtained metal is then purified by electrolytic refining.

Simply so, which is a sulphide ore?

Sulfide's characteristic trait of bonding a **sulfide** anion with various metals means that many important metal **ores** contain **sulfide** minerals. Some examples of **sulfides** include galena (the principle **ore** mineral for lead and silver), cinnabar (the main **ore** mineral for mercury), and chalcopyrite (which provides copper).

https://www.chemguide.co.uk/inorganic/extraction/copper.html

Extracting copper from its ores

The method used to extract copper from its ores depends on the nature of the ore. Sulphide ores such as chalcopyrite are converted to copper by a different method from silicate, carbonate or sulphate ores.

Getting copper from chalcopyrite, $CuFeS_2$

Chalcopyrite (also known as copper pyrites) and similar sulphide ores are the commonest ores of copper. The ores typically contain low percentages of copper and have to be concentrated by, for example, froth flotation before refining.

The process [Calcium carbonate in seashells! And silica is sand!]

The concentrated ore is heated strongly with silicon dioxide (silica), calcium carbonate and air or oxygen in a furnace or series of furnaces.

- The copper(II) ions in the chalcopyrite are reduced to copper(I) sulphide (which is reduced further to copper metal in the final stage).
- The iron in the chalcopyrite ends up converted into an iron(II) silicate slag which is removed.
- Most of the sulphur in the chalcopyrite turns into sulphur dioxide gas. This is used to make sulphuric acid via the Contact Process.
- Much like in the Blast Furnace, the calcium carbonate is involved in the production of the slag.

An overall equation for this series of steps is:

$$2CuFeS_2 + 2SiO_2 + 4O_2 \longrightarrow Cu_2S + 2FeSiO_3 + 3SO_2$$

The copper(I) sulphide produced is converted to copper with a final blast of air.

$$Cu_2S + O_2 \longrightarrow 2Cu + SO_2$$

The end product of this is called ***blister copper*** - a porous brittle form of copper, about 98 - 99.5% pure.

https://rockhoundresource.com/north-carolina-rockhounding-location-guide-map/

chalcopyrite occurs at Medoc Mountain, in Halifax Co. Also, note that bornite turns to chalconite upon exposure and weathering.

Deq.nc.gov mineral resources

North Carolina was the nation's leading gold producer prior to the 1849 discoveries in California. Because of its geologic similarity to important metal mining districts in Canada, the Carolina Slate Belt has been an area of extensive exploration. It is considered a good site for the discovery of base metal deposits (copper, lead and zinc) and gold associated with ancient hot-spring systems. The use of heap-leaching methods to recover gold from low-grade ore has revived interest in the slate belt. The recent development of four mines in South Carolina has encouraged continued exploration in similar geologic settings in North Carolina.

Shells from science center:

ER40L, 8D, 8F; all could be modern.

COAL & CHARCOAL

Fort Raleigh Inventory at NCHM

19XX.370.2 PIPE FRAGMENT. PART OF A STEM OF A CLAY PIPE. FOUND NEAR FORT RALEIGH, ROANOKE ISLAND IN 1897. TRANSFERRED TO ARCHAEOLOGY.

19XX.370.1 FLINT, GUN. FOR A FLINTLOCK GUN, FOUND NEAR FORT RALEIGH, ROANOKE ISLAND, 1897. SGC __MOH __03 __702A __MOVABLE STORAGE __3 __A __4 __ __C-1341.

1914.14.1 CHARCOAL 1580-1650. THREE PIECES OF CHARCOAL; FOUND FAR BELOW SURFACE NEAR THE CENTER OF FORT RALEIGH, ROANOAKE ISLAND, WHEN EXCAVATING FOR THE FOUNDATION OF THE MONUMENT TO VIRGINIA DARE. NOT LOCATED DURING 1960S INVENTORY.