

REINTERPRETING FORT RALEIGH OUTWORK-SCIENCE CENTER

Part 2 Science and Industry

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Part 2. Science and Industry

Part One of this report analyzed excavated structural features west of the Fort Raleigh earthwork sponce, their stratigraphic relationships, and parallel buildings. Part Two of the reinterpretation considers, first, evidence for the investigative work at the workshop carried out in 1585-86 by the scientist Thomas Harriot, the metallurgist Joachim Gans, and their assistants. Second, it identifies what industrial activities had taken place in the vicinity during that period, as indicated by documentary and archaeological evidence.

Several points considered here were more fully explored by Ivor Noël Hume in his 1995 archaeological report, *Archaeology at England's First Colony*, Eric Klingelhofer and Nicholas Lucchetti, eds, History Press, Charleston, SC, 2024.

Additional background material can be found in the following studies:

Lisa L. Heuvel, *Early Attempts of English Mineral Exploration in North America: The Jamestown Colony*, Virginia Division of Mineral Resources, Publication 176, Charlottesville, 2007.

Karin A. Amundsen, "Thinking Metallurgically: Metals and Empire in the Projects of Edward Hayes," *Huntington Library Quarterly*, 79, no. 4 (2016) 561–590 ([Thinking Metallurgically Metals and Empi.pdf](#)).

Jennifer Pinkowski, "The Alchemist Lab," *Archaeology*, Nov/Dec 2004, 26-31 ([Alchemy.pinkowski.pdf](#)); and the more detailed Marcos Martinón-Torres, Thilo Rehren & Sigrid von Osten, "A 16th century lab in a 21st century lab: archaeometric study of the laboratory equipment from Oberstockstall (Kirchberg am Wagram, Austria)," *Antiquity Journal archive* (<http://archive.antiquity.ac.uk/projgall/martinon298>).

Archaeometallurgy, Centre for Archaeological Guidelines, English Heritage, 2001 ([Archaeometallurgy.pdf](#)).

Corey Malcom, "Mercury on a Galleon," *The Navigator: Newsletter of the Mel Fisher Maritime Heritage Society*, Vol.22, No.2, March/April, 2006 ([Mercury on a Galleon.pdf](#)).

Andreas Hennius, "Viking Age tar production and outland exploitation," *Antiquity*, 92 365 (2018): 1349–1361 ([viking-age-tar-production-and-outland-exploitation.pdf](#)).

Agnes Latham and Joyce Youings, *The Letters of Sir Walter Raleigh*, University of Exeter Press, Exeter, UK, 1999.

Abbreviations used here: JCH = Jean C Harrington; RV = *Roanoke Voyages*, by David B. Quinn.

A. Science at the Compound

Discovery of valuable ores were a prime motivation for investment in colonization, where profitable trade routes to the Orient had proven unfounded. Previous colonizing ventures, failing to find a Northwest Passage, soon turned to Native societies for information about precious stones and metals. Cartier thought he had found diamonds in hills overlooking the St Lawrence River, and Frobisher shipped back tons of worthless iron pyrites from Baffin Island, instead of a fortune in gold ore. Raleigh was better prepared for his North American colony. Even as his men sought ways to reach an inland sea leading to the Pacific, he had already hired Joachim Gans, a trusted expert, to assay ores, while the gifted mathematician Harriot would pinpoint their find spots.

Thomas Harriot reported that 80 miles from Roanoke he visited two towns where the inhabitants had small plates of copper. 150 miles into the main “at the time of our first arrival into the Country”, he witnessed a werowance with “two small peeces of silver grosly beaten.... The affordsaide copper wee also founde by triall to hold silver.” (RV 333). Gans’s assay of native copper is evidenced by several lumps of smelted copper found by JCH and even copper prills (droplets) attached to ceramic sherds unearthed by INH.

A piece of worked antimony may have come from Europe or even a location near Aquia Creek on the west bank of the Potomac, later shown to Captain John Smith. Agricola describes how stibium (antimony sulphide) was used to separate silver from gold in the presence of copper. (*De Re Metallica*, Book X, 1556; 1912 ed., 451).

In the 19th century, visitors to the site found a small glass globe containing mercury, which is still used to refine both silver and gold. In the 16th and later centuries, however, it was also used in a variety of medical cures, especially for venereal disease. has been recovered in different forms on the *Mary Rose* and *Nuestra Señora de Atocha* shipwrecks.

It is helpful to turn to contemporary evidence for early colonial processing of precious metal ores. The Morgan Library’s *Drake Manuscript* is a French-language manuscript folio of primitive watercolors depicting plants, animals, and local activities witnessed by Sir Francis Drake’s circumnavigation of the globe (1577-1580) and his *Famous West Indian Voyage* (1585-86). The latest datable image, in fact, is that of a *Loranbec* hunter observed when Drake visited the Roanoke colony in 1586 (Norumbega = Northeast North America). Relevant here are two other scenes of smelting silver and gold on the Spanish Main. The smelting processes required different equipment, but both scenes show a building outside of which the smelting takes place. Furnaces at Roanoke were much smaller and presumably could be safely worked in a roofed structure.

The gold-smelting outdoor operation took place against a brick wall atop a tile-topped table supported by poles laid onto six waist-high forked ‘cratchets.’ A worker (probably indigenous) turns a bellows mechanism to bring oxygen into a round furnace, while a clothed Spaniard applies iron tongs to the flame. On the table are long handled tongs, a hammer and chisel, and



Drake MS, Spanish gold smelting



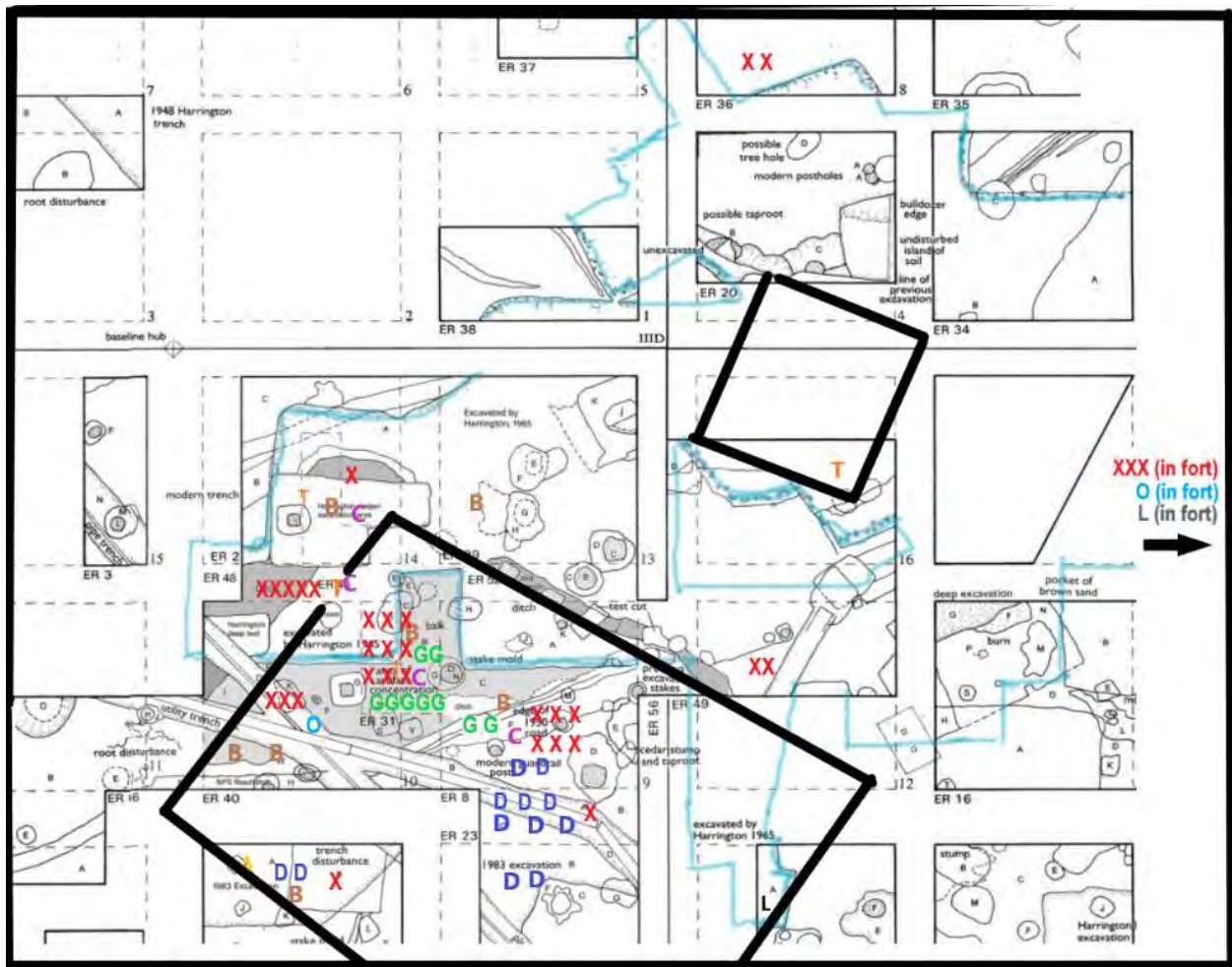
Drake MS, Spanish silver smelting

what appears to be a rectangular mold containing molten gold. Also on the table close to the Spaniard, a mug lies on its side and a raised bowl holds a whitish liquid or powder. On the ground are several ceramic objects, including a large amphora, plus a large whisk broom and a basket or tub. Spread under the table are what may be sticks of charcoal.

The gold operation's nearby structure has at least one open side (perhaps four), with squared timbers, pegged braces, and a tile roof. Inside the building are a balance scale, an anvil-and-stump, and a hanging bucket. Holding what looks like a tally stick, another Spaniard sits on a cushioned chair before what seems to be a desk and a paper account book with entry columns.

The building at the silver refinery is similar, but with a rafted roof of palm fronds. Hanging from the braces are a hammock, fruits, and what is probably a Seville-type 'olive' jar. The hammock suggests that workers slept on site. On the floor is a large amphora. A Spaniard holds what could be iron tongs and a pot (or large crucible?) containing silver ore. Outside, another large amphora stands behind a bellows-pumping Native sitting on a well crafted wooden bench. Among stacked kindling on the opposite side of the furnace, another worker kneels to open the vent for the liquid silver to pour through channels into molds.

At the Fort Raleigh science workshop, what remained of its working surface contained two aboriginal pots broken in situ and indications of several scientific activities. While assaying debris of crucible and English tiles were spread broadly throughout the area, cupels (absorbing 'litharge' waste from precious metal) were concentrated in the west, glassware in the center, and delft 'galley-pot' ointment jars to the east and south. It appears that Gans's metallurgical assaying took place on the west and Harriot's pharmaceutical analysis on the east. A line of small post holes that paralleled the palisade wall would have supported the kind of work bench that is depicted in alchemists' workshops. The large hole on the west may have served as a base for a furnace but more likely a stump, perhaps for an anvil, as the area does have iron flakes from an active forge. Contemporary images (see below) show stumps serving many uses; many also depict alchemist/assayers working at a raised chimney hearth, a workbench, or a table. It is most likely that Gans, the professional assayer, brought along his iron assay furnace and set it upon a table. He looked for evidence of gold, silver, copper, and iron. The furnace made of bricks of local clay at Roanoke would have served Harriot's pharmaceutical distillations. Illustrations indicate that assay furnaces had solid tops to control temperatures while distilling furnaces required a large circular hole for the cucurbit and alembic, combined as a retort.



1991-93 Artifact distribution.

North at top. Dark lines depict building outlines. Blue lines depict 1965 JCH excavation units. Most assaying cupels are in the west. Distilling glass is in the center. Most delfware apothecary jars are in the southeast.

Color Code: **A**=Antimony, **B**= Ballister storage jar, **C**= Cupil, **D**= Delft apothecary jar,
G= Glass, **L**= Lead, **O**= Olive jar, **T**= Tile, **X** = Crucible



Illustrations of 16C use of stumps and distilling furnace.

B. Industry at the Compound

In addition to the more scientific investigations of metallurgy and pharmaceuticals, the colonists staying on Roanoke over the winter of 1585-86 undertook several activities that produced usable items from natural sources.

Wood. Harriot wrote about “divers sortes of trees for house and shiptimbers: and other uses else: Also lime, stone, and brick.” (RV 363) He then listed several types of trees and their uses.

A broad axe and a smaller carpenter's axe found at Fort Raleigh prove that colonists were prepared to cut and fashion timber. Oaks, both white oaks and walnut, would have been used for housing. Less durable pine could quickly produce clapboards or roofing shingles, though there is no evidence for that. Pine would have been split for fencing and burned as fuel, or as Harriot noted, for pine tar and turpentine (see below). He also noted that cedar was excellent for furniture and boxes (RV 364). Sassafras was treasured for its "most rare vertues in phisick" (RV 329) and would have been collected and stored Harriot also wrote that samples of sweetgums were collected for testing as "Apothecary drugges" (RV 334), but were lost in 1586, when sailors tossed them from ship's boats in their haste to get safely on board.

The single commodity, after sassafras, most valued by the English was, in Captain Barlow's words, "the tallest and reddest Cedars of the World" (RV, 96-97). Harriot's *brief and true report* notes that cedar could be readily exported "if nests of chests be there made, or timber there fitted for sweet & fine bedsteads, tables, desks, lutes, virginalls & many things else (of which there hath been proof made already" (RV 329-30). In 1602, Raleigh complained to Secretary Cecil that a shipload of sassafras and cedar had brought from Virginia illegally by a London speculator. Of the 26 "sedar" trees, Raleigh would use them to "seale" [panel] cabinneats and make bords and many other delicate things" (Latham, *Letters*, no. 161).

Charcoal. Wood burning is unable to reach the temperature needed for a metallurgical furnace, but charcoal can reach temperatures as high as 2010°F. Silver melts at 1761°F, copper at 1983°F, and gold at 1945°F. The quantity of excavated charcoal from pine here indicate it was produced for such a furnace, but it could also have been used in braziers to heat rooms in the winter.

Clay.

Common clay exists in pockets at Fort Raleigh. One such was undoubtedly dug out by the 1585 colonists and reused, the feature called by JCH the "Charcoal Pit." In 2008, another was located south of the earthwork by Time Team America's geophysical specialist and was ground-truthed by FCF. Common clay was used to make the furnace bricks, first discovered by JCH in 1965. It also would have been used as daub for wattle walling, hearths, and chimneys.

Medicinal clay was identified by Harriot *terra Sigillata* (RV 328). It was commonly used as a digestive and diarrhea control, and applied topically to heal lesions from poison ivy, etc. A small sample of kaolin, which is found west of the Coastal Plain, but not on Roanoke, was excavated at the science workshop. Two small objects of "white stuff" were found within the workshop in a likely JCH survey hole backfill (SEAC acc. 907, #71, #72). If not kaolin, these items might have been mercury amalgam, an assay waste product.

Iron-working. Iron flakes, evidence of smithing, were found in the western part of the workshop. An English voyage in the 16th century commonly set up a forge to manufacture nails and other fittings while the ship was cleansed and took on fresh water. John White's watercolor of Grenville's encampment in Puerto Rico illustrates just that.

Water. The site lacked the necessary water supply, but not far to the northeast, at least two barrel-lined wells (retrieved from the Sound by PWE) were dug into the slope down to the presumed landing area. Other barrels, kegs, and Seville-made ‘oil’ jars would have brought water to the compound. Workers, soldiers, and sailors drank from canteen-like wicker covered stoneware costrels from northern France. Leather flasks and flagons would also be typical of the period.

Thatch. The sole reference to roofing is by Lane: “they would have beset my house, and put fire to the reedes, that the same was covered with” (RV 282). The sickle found by JCH and on display at FORA was undoubtedly used to cut reed to thatch roofs.

Fishing. Although Governor Lane reported that his men lacked skills to repair Algonquian weirs and were thus deprived of food, there is evidence here for other forms of fishing. A small iron fishhook was unearthed in the compound, but it cannot be displayed because conservation treatment came too late. Nets would also have been used. Associated with the remains of the barrel recovered in the Sound was a broken wooden object. Study proved it to be a lucet, a hand-held two-pronged tool for making cords, suitable for netting. And we must not forget the fate of George Howe, a leader of the 1587 colony, who was murdered “without any weapon, saving onley a small forked sticke, catching Crabs therewithal...”(RV 527).

Grain. Maize was a staple for local tribes and thus also for the English, most of whose food supplies had been ruined. There is no evidence of cooking in the science compound, but an object recovered from Sound may well be evidence food preparation. One of the barrel wells proved to be a hollow log. From its size and hints of alterations at a damaged end, it appeared similar to a dried corn kernel separator, recorded as having been used only by the southern Algonquians. A FCF visit to the Smithsonian Institution confirmed that similarity. Damaged by use or overuse by the English, they then converted it to a second well.

It should be noted that credit for this unique archaeological evidence goes to two former FORA rangers, Phil Evans on the discovery, recovery, and preservation of the hollow log and Rob Bolling on its identification as an Algonquian-then-English artifact.

Brewing. Harriot also experimented on Roanoke with maize. He noted that it made excellent cakes (cornbread), and that “We made of the same in the countrey some mault, whereof was brewed as good Ale as was to bee desired” (RV 338).

Oil. Harriot pointed to walnuts, acorns, and bears as proven sources of oils (RV 330). Rendering and storage of oils, perhaps in Seville ‘olive’ oil vessels, is likely, but lacks direct on-site evidence.

Tar. JCH recorded the only possible example of pine tar, near the watchtower: “Feature 65-6: Oblong hole with pitch or tar in bottom. A similar deposit was found near the surface. It contained the identical material of pitch or tar. Embedded in it was a piece of thin iron (possible from a “tin pail”) which does not appear to be old. This feature... and the higher deposit must be relatively recent.”

APPENDIX A: Notes on Alchemical and Metallurgical Images

Information drawn from contemporary illustrations 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; print of workshop in Lazarus Ercker's *Mineralischen Ertz*, Book 5 (1574).

To the ten are added two more from the Drake Manuscript.

Structures: wooden w brick walls, or framed w infill of wattle & daub or stone. 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.

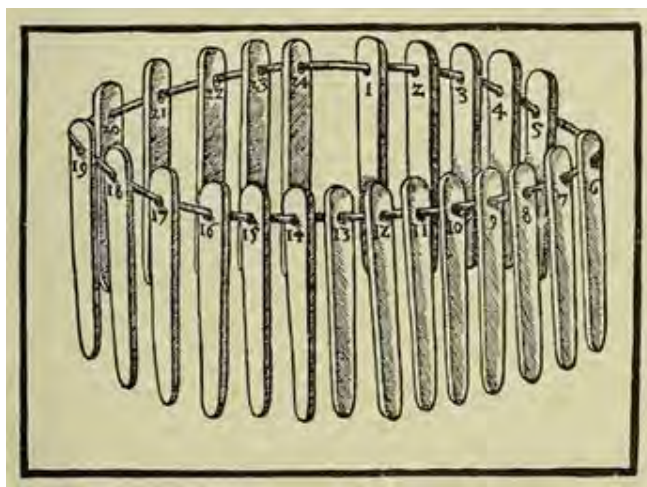
Another is a waist-high arched wall furnace. No sign of fire mouth; was fire directly on surface? Similar one of brick is knee-level but has a broad fire mouth used only for storing pots. Fire is on surface with wood used. Another image has a similar waste high fireplace, with unused arch below. Fire 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: workbenches, 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 and bottles, hanging cresset lamp, brass pot with spigot, hourglass with hexagon (and possibly round) bases, mortar and pestle (a large one w rope attached to suspended bend rod), flat tongs, iron pan with rim & thumb-handle, brass pan with rim, brass cauldron with three iron long legs, metal ‘stirrers’ of spearhead shape, thin wooden stirring rod, stump on working surface, baskets, pipkins, delft pharmaceutical jars with paper-and-string covers, paper sachets, chisels, file, two-head and fork-end hammers, anvil, handpick, long-handled hinged or bent tongs, scissors or clippers, awls, gouge, wood handled curved knife, folding knife or razor, strike-a-light, long wooden spoon, balance scales with weights, assay touchstone and ‘needles’ on ring, metal ladle, large rotary press for crushing ore, a handled wooden ‘tablet’ with vertical slot to look at assay.

Note: there is no no example of suspended bellows, though Agricola does show one, a ‘double bellows’ in a frame.

Containers leather & cloth pouches with 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 or ceramic bottles with cloth as stoppers.



Agricola, assay 'needles.

APPENDIX B: Contemporary Images



1. Stradamus, Alchemists distilling

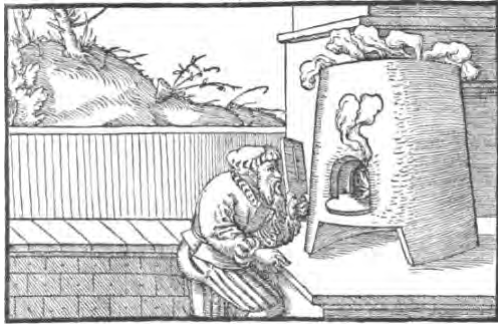


2. Weiditz, Alchemist

Der Schriftgießer.



3. Amman, font maker with furnace, 4. Alchemist's workshop, ca 1600, with symbols



ROUND ASSAY FURNACE.



RECTANGULAR ASSAY FURNACE.

5. Agricola, assay furnaces



6. Agricola, silver smelting w butter pot



7. Zachar, reconstructed alchemical room



8. Pieter Bruegel, Alchemist



9. David Teniers, Alchemist



10. David Teniers the Younger, Alchemist

Die Körnkellen A. der Windtöfen B. Ein ander windtöfen von Töpffers-
zeug auff ein Dreyfuß C. der tiegel darcin das Silber geschmelzt wird D.
der Schöpfstigel E. das Kupffern becken / darin das gefürnt treug gemacht
wird F. ein Eyserner Koff / darauff das Silber geschigt wird G. der Körner
H. der besenhalter. K.



Wie

11. Lazarus Ercker, *Mineralischen Ertz*