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Byzantine Enamel and the Aesthetics of Technological Power, Ninth to Twelfth Centuries

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Abstract

Beginning in the ninth century C.E., artisans in the Byzantine Empire mastered the complex process of cloisonné enameling – fusing colored glass to metal plaques divided into compartments by delicate metal wires. Enameling demanded fluency in the physical properties of multiple materials and proficiency in what we know today as graphic design. This dissertation emphasizes how the ability to manufacture enamel was significant in and of itself, and explores how cloisonné enamel became infused with cultural meaning in Byzantium through the rarefied technical knowledge employed in its making.

The medieval Greek vocabulary for enamel, χυμευτός/χειμευτός (*chymeutos*/*cheimeutos*) and ἔργα χυμευτά/χειμευτά (*erga chymeuta*/*cheimeuta*), derives from the verb χεώ (*cheō*, "to melt"), and can be translated as "melted things," or "melted work." Yet the stem of the words and their etymological origins link them firmly to the terms χυμεία/χημεία (*chymeia*/*chēmeia*) and χύμευσις (*chymeusis*), the medieval Greek words for "alchemy." A large corpus of Byzantine alchemical texts reveals that the relationship between enameling and alchemy was more than etymological, it was fundamental.

I argue that, beyond being a means of artistic representation, Byzantine enamel was the aesthetic manifestation of material sciences and a potent statement of technological prowess. This study brings the material characteristics of enameled objects into dialogue with literary evidence of alchemical practice in Byzantium. Notions of technological power are the ideological undercurrent running below the surface of this medium, hinting

that the expert manipulation of minerals, glass, and metals could also stand in for Byzantine mastery over the natural world itself.

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All dates are common era (C.E.) unless otherwise noted.

Greek terms have been translated by consulting a variety of lexicons, with preference given to definitions in Henry George Liddell, Robert Scott, and Henry Stewart Jones, *Greek-English Lexicon* (Oxford: Clarendon Press, 2006), E.A. Sophocles, *Greek Lexicon of the Roman and Byzantine Periods (from B.C. 146 to A.D. 1100)* (Whitefish, MT: 2010), and Erich Trapp, *Lexikon zur byzantinischen Gräzität besonders des 9. – 12. Jahrhunderts* (Vienna: Verlag des Österreichischen Akademie der Wissenschaften, 2017).

Greek transliterations have been preferred over Latin transliterations, for example, "Doukas," not "Ducas." Names and terms commonly transliterated in Latin are maintained, however, for example "George" instead of "Georgios."

Introduction

The art of vitreous enameling takes ordinary glass and metal and fuses them into dazzling, jewel-like objects. Enameling captured the medieval imagination and became a technique distinctive to the art production of the Byzantine Empire, perhaps even moreso than mosaic. A quatrefoil clasp or closure dated to the tenth or eleventh century and now in the Dumbarton Oaks Collection in Washington, D.C., is representative of the typical Byzantine enamel (Fig. 1). It is executed on gold, diminutive in size (2.3 x 5cm), and bears images of the Virgin Mary on one side and Christ on the other side (Fig. 2). Wires threaded through loops on the outside edge of the quatrefoil suggest it was once framed with seed pearls. The enamel proper, that is, the powdered glass that has been fused to the metal support, is sunk into a chased or stamped depression to create the illusion that the figures float on a background of pure gold. The figures themselves are composed of a network of cells constructed from thin gold wires. The glass fill consists of bright, translucent hues of blue, purple, and green, complemented by opaque white, red, and yellow. The juxtaposition of translucent and opaque colors causes the glass to shimmer in the light, adding a subtle vibrancy to an otherwise minimalist composition. The quatrefoil impresses with its seamless meeting of glass and metal, its lively use of color, and the delicate rendering of forms. The combination of material splendor and precise artistry inspires awe, prompting viewers to wonder at how it was made.

In 1912, O. M. Dalton remarked, “so from one enameled medallion we might infer the bias of the Byzantine genius, were every monument of its greater art

destroyed."[1] Despite the fact that Dalton relegated enamel to the secondary status of a minor art, his statement makes a bold point: enamel has a capacity to convey a Byzantine understanding of the world in ways that other types of art cannot. Indeed, enamels such as the quatrefoil exemplify several aesthetic qualities that Byzantine patrons and viewers valued highly, including dynamic reflectivity, vivid and varied color, and mixed materials.[2] But these aspects do not account for the entirety of Dalton's sentiment.

Enamel's ability to encompass a Byzantine worldview might be characterized best by the famous verses of W. B. Yeats' "Sailing to Byzantium":

> Once out of nature I shall never take
> My bodily form from any natural thing,
> But such a form as Grecian goldsmiths make
> Of hammered gold and gold enameling[3]

Yeats' poem is a celebrated, if now cliché lamentation of the indignities of mortality contrasted with the eternal perseverance of the spirit and art. This stanza, however, strikes

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[1] O. M. Dalton, "Byzantine Enamels in Mr. Pierpont Morgan's Collection," *The Burlington Magazine for Connoisseurs* 21, no. 112 (1912): 219–25.

[2] The bibliography documenting these aesthetic values is vast, see for example Liz James, *Light and Colour in Byzantine Art* (Oxford: Clarendon Press, 1996); Bissera Pentcheva, *The Sensual Icon: Space, Ritual, and the Senses in Byzantium* (University Park: The Pennsylvania State University Press, 2010); Ioli Kalavrezou, "Light and the Precious Object, or Value in the Eyes of the Byzantines," in *The Construction of Value in the Ancient World*, ed. John K. Papadopoulos and Gary Urton (Los Angeles: Cotsen Institute of Archaeology Press, 2012), 354–69.

[3] W. B. Yeats, "Sailing to Byzantium," in *The Poems of W. B. Yeats*, ed. Richard J. Finneran (New York: Macmillan, 1961), 102.

straight to the core of what makes enamel so arresting. Enamel is not the product of nature, but rather human artifice. As a completely man-made material, enamel testifies to humanity's power to shape, manipulate, and command the physical world. In this dissertation I propose that the "Byzantine genius" that Dalton (and Yeats) recognized in enamel is ultimately the impetus of all empires – the pursuit and acquisition of power through human agency, knowledge production, and innovation. In other words, enamel is a technology.

Technology, broadly speaking, is the organization and application of knowledge for the achievement of a purpose.[4] Enamel evinces expertise in materials, their properties, and their processing. The knowledge at work in enamel as a technology is knowledge of the behavior of matter. That the Byzantines were aware of enamel's technological dimensions is evident in the medieval Greek words for enamel, χυμευτός/χειμευτός (*chymeutos*/*cheimeutos*) and ἔργα χυμευτά/χειμευτά (*erga chymeuta*/*cheimeuta*). These terms derive from the verb χεώ (*cheō*, "to pour, fuse, or melt"), and they can be translated literally as "melted things," or "melted work." Yet the stem of the words and their etymological origins link them firmly to the terms χυμεία/χημεία (*chymeia*/*chēmeia*) and χύμευσις (*chymeusis*), the medieval Greek words for "alchemy." Therefore a more accurate translation of enameling terminology might well be "alchemical things" and "alchemical work."

In our modern perception, alchemy conjures images of wizened old men engrossed in the pseudo-scientific folly of trying to turn lead into gold. Yet, as many

[4] I take my definition from W. Brian Arthur, *The Nature of Technology: What It Is and How It Evolves* (New York: Free Press, 2009), 28.

recent studies have pointed out, alchemy was an important precursor to the modern scientific tradition, responsible for both important scientific discoveries and for the development of the scientific method.[5] Although not strictly "scientific" in a modern sense, alchemy in medieval Byzantium was a sophisticated endeavor to understand the qualities, behaviors, and operations of matter found in nature.[6] It was practiced and studied by the most accomplished Byzantine intellectuals, such as the eleventh-century polymath, historian, and courtier Michael Psellos (ca. 1017 – 1078). Alchemy is also often associated with magic.[7] While in premodernity the lines between alchemy and magic frequently blurred, in medieval Byzantium alchemy was not so much magical as it was powerful.[8] Alchemy sought to uncover the workings of matter, the very fabric of the

[5] William R. Newman, *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2004); Lawrence Principe, *The Secrets of Alchemy*, Synthesis (Chicago: University of Chicago Press, 2013).

[6] As Gerasimos Merianos has succinctly put it, "Alchemy aims to interpret and comprehend the constitution and function of the cosmos and, consequently, to acquire the knowledge that would lead imperfect matter to perfection through the application of fundamental natural principles. It is therefore conceived in a philosophical framework, in which alchemists act as interpreters of nature." Gerasimos Merianos, "Alchemy," in *The Cambridge Intellectual History of Byzantium*, ed. Anthony Kaldellis and Niketas Siniossoglou (Cambridge: Cambridge University Press, 2017), 237.

[7] For a persuasive reading of alchemy's magical aspects, see Radcliffe G. Edmonds, *Drawing Down the Moon: Magic in the Ancient Greco-Roman World* (Princeton: Princeton University Press, 2019), 311–13.

[8] For example, see Psellos' vehement denial that alchemy is occult or forbidden, see Appendix I, section 1.

world, as well as to control and manipulate it. Following the definition of technology as knowledge applied with a purpose, alchemy, too, is a technology.

Taking these definitions as a point of departure, this study argues that Byzantine enamel manifests the cultivation of an aestheticized technology. I propose that enamel's relationship to alchemy was more than just etymological; it was essential to the experience and appreciation of enamel in Byzantine society. As part of a larger alchemical endeavor, enamel joined a material dialogue between nature and humanity. In making enamel, Byzantine artisans intervened in natural processes, commanding glass, metal, and heat, and coercing them into figural representations and ornamental decoration. Enamel facilitated communication of alchemical knowledge between its makers, who worked with matter directly, and its users, for whom the association with alchemy could be interpreted symbolically or enjoyed for its prestige. Most of all, enamel embodied the power over nature implied by its alchemical origins and gave that power a physical form to be admired.

Before exploring these arguments in greater depth, some preliminary issues must be addressed. In the remainder of the Introduction, I first discuss what types of techniques and objects qualify as Byzantine enamel. Scholars have traditionally defined Byzantine enamel by technique, date, and place of production. But these systems of categorization are modern, and Byzantine patrons and viewers assessed and ordered enamel quite differently. In addition to reassessing some questions of technique and dating, I resituate enamel in its proper conceptual place by considering Byzantine definitions that connect enamel and enameling with the practice of alchemy. I next turn to the historiographic challenges in studying Byzantine enamel. I provide a brief overview of how scholars

have approached Byzantine enamel in the past and outline my own approach, which is informed by methods drawn from experimental archaeology.

What is Byzantine Enamel?

Enamel is glass fused to metal by means of extreme heat. Methods of enameling are many, but the basic process remains the same. The enameller grinds glass into a powder, mixes it with water, and applies it to a metal substrate. The piece is fired at temperatures upwards of 1000 degrees Fahrenheit for as long as it takes the glass to melt and fuse to the metal support, usually a matter of seconds. Once cooled, the glass contracts and the process must be repeated until the glass reaches the desired height. The finished enamel is then polished using lapidary tools and water. Premodern enamel colors could not be mixed with one another, so form and expression are achieved through line and the juxtaposition of solid colors rather than through modeling. Once completed, enamel is very durable. Many medieval enamels retain their smooth surfaces and luster.

Byzantine enamellers preferred to work in a technique known as *cloisonné*, and they preferred to enamel on gold as their substrate. In *cloisonné* enameling, the design is constructed from cells made of thin wires or strips of metal. These distinctive cells, or *cloisons*, give the technique its name. An eleventh-century plaque representing Saint Peter, now in the Metropolitan Museum of Art in New York, illustrates the *cloisonné* technique (Fig. 3). Now damaged and pitted from exposure during burial, the supporting system of metal strips is visible where the glass fill has fallen out, especially in the areas of the saint's left shoulder, right knee, and feet. Still visible also is the fretwork of lines that articulate the folds of his drapery, the expression of his face, and the gestures of his

hands. *Cloisonné* is a tedious and labor-intensive technique. However, the cells satisfy the need to keep different colors separate, and the wires allow for the exhibition of fine drawing and design.

The decision to enamel on gold is in part technical, because gold has a higher melting temperature than glass. Silver is not ideal because its melting point is too close to that of glass. Copper also has a higher melting temperature than glass, but gold remained the substrate of choice for Byzantine enamellers. One property of gold that copper lacks is its resistance to oxidation, which allows it to maintain high reflectivity. For this reason, transparent enamels function best on gold, which allows for maximum effects of light and color, two of the most important aspects of Byzantine aesthetics. It should be noted, however, that Byzantine enamellers experimented. They enameled on copper and silver.[9] They employed techniques such as *champlevé,* in which the powdered glass is placed in chased or engraved depressions in the metal support rather than in wire cells. One example of Byzantine *champlevé* enamel on silver is an icon revetment in the treasury of San Marco in Venice (Fig. 4).[10]

A distinctive feature of the modern study of Byzantine enameling is the division of *cloisonné* into two sub-techniques commonly known by the German terms *vollschmelz*

[9] For example, an enameled icon of St. Theodore Stratelates now in the State Hermitage Museum (St. Petersburg) is executed on copper.

[10] On this icon revetment see H. R. Hahnloser, ed., *Il Tesoro di San Marco*, vol. II, *Il Tesoro e Il Museo* (Florence: Sansone Editore, 1971), 30.

("full enamel") and *senkschmelz* ("sunk enamel").[11] In the interest of accessibility, I have chosen to use the English translations of these terms throughout this study. In full enameling, the entire surface of the metal substrate is covered with glass fill divided by *cloisons*, as in an eleventh-century pendant reliquary of Saint George and Saint Demetrios now in the British Museum in London (Fig. 5). In sunk enameling, *cloisons* are fashioned inside of a chased or stamped depression and filled until they are flush with the metal substrate. This gives the appearance that the enamel is "sunk" into a gold background. While full enamel was popular throughout the medieval world, sunk enamel appears to have been a Byzantine invention. The earliest examples are a set of tenth-century plaques from a woman's crown found in the medieval Bulgarian capital of Preslav, Bulgaria, and now in the Archaeological Museum Veliki Preslav (Fig. 6).[12] In many cases, the reverse of sunk enamels show traces of the design process in the form of stippled lines to designate the placement of *cloison* wires, as seen in an eleventh-century medallion now in the Musée du Louvre in Paris (Fig. 7). While the earliest Byzantine enamels are executed in full enamel, once sunk enamel was developed, Byzantine enamellers used both techniques conterminously.

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[11] The terms were first introduced in Marc Rosenberg, *Geschichte der Goldschmiedekunst auf technischer Grundlage: Zellenschmelz*, vol. 2 (Frankfurt: Verlag Heinrich Keller, 1921), 63–66.

[12] The crown is associated with the marriage of a Byzantine princess, Maria-Irene Lekapene (d. 966) to Peter I of Bulgaria (r. 927 – 969) in 927 and is part of the so-called Preslav Treasure, excavated in 1978. See Jannic Durand, ed., *Le trésor de Preslav: reflet d'un âge d'or du Moyen Âge bulgare* (Paris: Somogy, Éditions d'art, 2018), 4-6; Georgi Atanasov, "On the Origin, Function and the Owner of the Adornments of the Preslav Treasure From the 10th Century," *Archaeologia Bulgarica* 3, no. 3 (1999): 81–94.

No archaeological remnants of enameling workshops have been found anywhere in the former Byzantine Empire.[13] As a result, particularities of technique usually determine which extant enamels are classified as Byzantine. Until the late 1980s, scholars believed that Byzantine enameling traced an unbroken technical lineage back to Greek and Roman enameling.[14] Crucial to this claim was a work of enamel identified as a dress ornament in the Walters Art Museum in Baltimore (Fig. 8). The round, gold medallion features a cross in its center flanked by a *globus cruciger* on each side. A wreath pattern surrounds the central cross, while the outermost rim of the enamel is decorated with lozenges and rosettes. Once dated to the fifth century, the Walters medallion featured prominently in studies of Byzantine enamel as evidence that enameling in Byzantium extended as far back as late antiquity.[15] Scholars such as Klaus Wessel and Marvin C. Ross praised the medallion for its fine wirework and compared it to examples from

[13] In the case of other artistic processes, such as copper smithing and ironworking, the archaeological discovery of workshop remains and tools have provided information on the technique itself, the tools used, and where these artisans were located in a given city.

[14] For an overview of this timeline see Klaus Wessel, *Byzantine Enamels from the 5th to the 13th Century* (Greenwich, CT: The New York Graphic Society, 1968), 15.

[15] Wessel, *Byzantine Enamels*, 15; Marvin C. Ross, "Byzantine Enamels," in *Byzantine Art, an European Art; Lectures* (Athens: Department of Antiquities and Archaeological Restoration, Greek Government, 1964), 391-408.

Roman Egypt and Hellenistic Greece.[16] With the eventual aid of technical analysis however, the Walters medallion was ascertained to be a nineteenth-century forgery.[17]

This discovery ignited a fierce scholarly debate over the question of when enameling came to Byzantium, from where, and what techniques were used. In 1988, David Buckton argued convincingly that Byzantine artisans produced no enamel until the ninth century. Moreover, he posited that Byzantine enamellers took Carolingian enamel as their inspiration, and that the true unbroken lineage of enameling lay in the medieval West.[18] He compared, for example, a reliquary cross that bears a Latin inscription naming Pope Paschal I (fl. 817 – 824), now in the Vatican Museums in Rome, with well-known monuments of Byzantine enameling such as the ninth-century Beresford-Hope cross now in the Victoria and Albert Museum in London, noting their similar style (Figs. 9 and 10). Buckton even accounted for the survival of objects such as a pectoral cross in the Dumbarton Oaks Collection decorated with birds, which was discovered in a sixth- or

[16] Wessel, *Byzantine Enamels*, 15; Ross, "Byzantine Enamels," 391.

[17] The blue and green glass fill of the Walters medallion contained traces of arsenic, an element not used in glass processing until the seventeenth century. On the analysis and re-dating of the medallion, see Terry Drayman-Weisser and Catherine Herbert, "An Early Byzantine-Style Gold Medallion Re-Considered," *The Journal of the Walters Art Gallery* 49/50 (1991): 13–25; Julian Henderson, "A Scientific Analysis of the Enamel Decorating a Gold Medallion in the Walters Art Gallery," *The Journal of the Walters Art Gallery* 49/50 (1991): 27–31.

[18] David Buckton, "Byzantine Enamel and the West," *Byzantinische Forschungen* 13 (1988): 235–54.

seventh-century hoard in Syria (Fig. 11).[19] This object, he asserted, was not true *cloisonné* but rather "filigree" enamel, characterized by rounded wires and watery, unsaturated color.[20] Robin Cormack provided a rebuttal, claiming that earlier examples of Byzantine enamel might have been lost in the destruction of art that followed the Iconoclast controversy (726-843).[21] Despite Cormack's best efforts, however, scholars have continued to agree with Buckton's arguments for the better part of three decades.

Over the years, a number of problems have emerged in Buckton's model. Most pressing is the fact that while Buckton constructed his timeline around details of technique, the Byzantines appear not to have made such a distinction between enameling techniques at all. There are no terms nor any descriptions of enamel in Byzantine textual sources that differentiate objects based on *cloisonné*, filigree, or even *champlevé* enameling. Similarly, there is no Byzantine vocabulary distinguishing full enamel from sunk enamel. Without textual attestation of a distinction in technique, Buckton's assertion that no Byzantine enamel was produced before the ninth century is refuted by the existence of enamels dated earlier, such as the Dumbarton Oaks cross (see Fig. 11) and

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[19] On the date and findspot of the cross, see Marvin C. Ross, *Catalog of the Byzantine and Early Medieval Antiquities in the Dumbarton Oaks Collection: Jewelry, Enamels, and Art of the Migration Period*, 2nd ed., ed. Stephen R. Zwirn and Susan A. Boyd, vol. 2 (Washington, D.C: Dumbarton Oaks Research Library and Collection, 2005), 136.

[20] Buckton, "Byzantine Enamel and the West," 237.

[21] Robin Cormack, "Reflections on Early Byzantine Cloisonné Enamels: Endangered or Extinct?" in *Θυμιαμα στη μνήμη της Λασκαρίνας Μπούρα* (Athens: Benaki Museum, 1994), 67-72.

other works like it.[22] Furthermore, new technical analysis sheds light on the similarity between Carolingian and Byzantine enamel. In a study of the enamels in the collection of the British Museum, conservator Ian C. Freestone and his team identified a common source of glass for both Byzantine and Carolingian enamels. Samples revealed that Byzantine enamels dated between the ninth and eleventh centuries were composed of a different formula than contemporary Byzantine window or mosaic glass.[23] The formula was consistent, however, with sixth- and seventh-century mosaic glass from Italy, implying that Byzantine enamellers recycled antique mosaic tesserae for the formulation of their enamel glass. This revelation suggests new possibilities, such as communication and exchange between Byzantine and Carolingian artisans as they sourced materials for their craft. At the very least, the breakdown of Buckton's strict, technical- and style-based timeline indicates that the question of the origins of Byzantine enamel must remain open.

In Byzantine sources, all enamel is called *chymeutos* or *erga chymeuta*, and these terms can both help establish parameters of dating and give insight into how the Byzantines conceptualized enamel. Variations the term of *chymeutos* appear as early as the seventh century and as late as the sixteenth, but the term flourished between the tenth

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[22] Two more comparable enameled crosses survive in the Bargello collection in Florence, see Günther Haseloff, *Email im Frühen Mittelalter: Frühchristliche Kunst von der Spätantike bis zu den Karolingern* (Marburg: Dr. Wolfram Hitzeroth Verlag, 1990), 23–25.

[23] Ian C. Freestone, S. G. E. Bowman, and C. P. Stapleton, "Composition and Origins of Byzantine and Early Medieval Enamel Glasses," Unpublished Research Report, British Museum Department of Scientific Research File No. 6078. I thank Ian C. Freestone for sharing this unpublished report with me.

and twelfth centuries.[24] Over the span of three centuries, *chymeutos* proliferates in histories, manuals of court protocol, poetry, aristocratic wills, and monastic inventories.[25] Beginning in the seventeenth century, philologists associated the term with both enameling and alchemy. Yet few scholars have taken enameling vocabulary seriously as an indicator of what enamel represented in the Byzantine imagination. The Greek scholar Leo Allatios (c. 1586 – 1669) commented on a passage in the Byzantine biography of emperor Basil II (r. 976 – 1025) that describes the enameled decoration of a church in the Great Palace of Constantinople using the term περικεχυμένον (*perikechymenon*, "all-enameled"). Allatios translated the word as "chemically-painted."[26] This association of

[24] The earliest instance of a variation of *chymeutos* is in the sixth-century *Hexameron* of Anastasius of Sinai, a twelve-book commentary on the Act of Creation. Anastasius of Sinai, Bk. 8 Ch. 3. A search of the *Thesaurus Linguae Graecae* reveals that the latest instance is found in sixteenth-century copies of the Byzantine epic poem *Digenes Akritas.*

[25] For example, see Ihor Ševcenko, ed., *Chronographiae quae Theophanis Continuati nomine fertur Liber quo Vita Basilii Imperatoris amplectitur* (Berlin: de Gruyter, 2011), 285-87; Ann Moffatt and Maxeme Tall, eds., *The Book of Ceremonies* (Queensland: Australian Association for Byzantine Studies, 2012), 99, 170-71, 570-97, 640; Elizabeth Jeffreys, ed., *Diginis Akritis: The Grottaferrata and Escorial Versions* (Cambridge: Cambridge University Press, 1998), 67-72; Speros Vryonis Jr., "The Will of a Provincial Magnate, Eustathius Boilas (1059)," *Dumbarton Oaks Papers* 11 (1957): 263–77; Angela Hero, Giles Constable, and John Philip Thomas, eds., *Byzantine Monastic Foundation Documents: A Complete Translation of the Surviving Founders' Typika and Testaments*, 5 vols. (Washington D.C.: Dumbarton Oaks Research Library and Collection, 2000), 121-25.

[26] See Leo Allatius, ed. and trans., "Constantinus Porphyrogenneta De vita et gestis Basilii Macedonis Imperatoris," in *Leonis Allatii Σύμικτα, sive opusculorum, Graecorum et Latinorum, vetustiorum ac recentiorum, Libri duo*, ed. Bartholdus

chymeutos and its variants with chemistry persisted into the nineteenth century, when Nikodim Pavlovich Kondakov published his extensive study of Byzantine enamel. Kondakov noted that the term *chymeutos* "refers to the involvement of alchemists or chemists in the art of enameling," but he did not pursue the connection further.[27] Oblique or passing references to enamel's relationship to alchemy also appear in studies of Byzantine alchemy. In 2006, Michele Mertèns mentioned enamel in a footnote and tentatively suggested that Byzantine luxury arts had peripheral ties to alchemical practice.[28] More recently, Gerasimos Merianos has urged scholars studying alchemy to investigate its connections with art production, using enamel as an example.[29]

Philology has opened a conversation about enamel's alchemical dimensions, but the most definitive link between enameling and alchemy is the presence of "recipes" for enameling in extant Byzantine alchemical texts. In the late nineteenth century, French organic chemist Marcellin Berthelot and Hellenist Charles Émile Ruelle collated and edited the *Collection des anciens alchimistes grecs*, a three-volume collection of

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Nihusius, 2 parts in 1 vol. (Coloniae Agrippinae: Apud Iodocum Kalcovium, 1653), 2:149-150. I thank Vangelis Koutalis for sharing this citation.

[27] "Die bei den Griechen üblischste Bezeichnung für Email, 'χυμευτόν' statt 'χειμευτόν' weist fast auf die Bethätigung der Alchymisten oder Chemiker an der Emaillirkunst hin." Nikodim Pavolvich Kondakov, *Geschichte und Denkmäler des byzantinischen Emails* (Frankfurt: August Osterreith, 1892), 76.

[28] Michèle Mertens, "Graeco-Egyptian Alchemy in Byzantium," in *The Occult Sciences in Byzantium*, ed. Paul Magdalino and Maria V. Mavroudi (Geneva: La Pomme d'or, 2006), 225, n63.

[29] Merianos, "Alchemy," 241-42.

alchemical texts in Greek that survived in Byzantine manuscripts.[30] Known contemporaneously as the Greek alchemical corpus, the texts range in date from the first through thirteenth centuries. They are comprised of treatises on alchemical subjects ranging from making gold and silver from base metals to the production of imitation gemstones and purple dye. In the course of this study I have identified two sets of instructions for enameling within the Greek alchemical corpus, one dated between the eighth and tenth centuries, and the other dated to the eleventh century.[31]

The chronological range of this study is the ninth through twelfth centuries, a period bracketed at the beginning by the earliest Byzantine enamel with a secure date, a votive crown depicting the emperor Leo VI (r. 886 – 912) now in the Treasury of San Marco in Venice, and at the end by the near absence of the term *chymeutos* in Byzantine literary production by the late twelfth century.[32] While enamel was produced in Byzantium both before the ninth century and after the twelfth, it was not associated with alchemical practice. In this study I focus solely on enamel thought to be produced during the period in which the term *chymeutos* was in active use.[33] This study analyzes Byzantine enamels as alchemical artifacts in keeping with Byzantine definitions, and I

[30] For a discussion of the composition of the Greek alchemical corpus see Merianos, "Alchemy," 236. I discuss the Greek alchemical corpus in greater detail in Chapter One.

[31] In Chapter Three, I discuss these recipes in detail, and, in Appendices II.A and II.B, I provide translations together with the original Greek texts.

[32] For discussion of the votive crown of Leo VI, see Chapter Three.

[33] I accept the current scholarly consensus for the dating of Byzantine enamel objects, and I summarize the state of debate in the case of unresolved attributions.

prioritize the Byzantine conception of enamel as an alchemical art over modern categorizations based on technique or style.

The Modern Study of Byzantine Enamel

Historically, Byzantine enamel has captivated modern scholars as surely as it captivated Byzantine patrons and viewers. As this study relies upon these scholars' expertise, it is useful to review the history of how enamel has been studied.

To date, the most comprehensive study of Byzantine enamel is Nikodim Kondakov's *Geschichte und Denkmäler des byzantinischen Emails,* also titled *Histoire et monuments des émaux byzantins*, published in 1892. Eight years earlier, the Russian collector Alexander Swenigorodskii hired Kondakov to produce a study to accompany the catalogue of Swenigorodskii's collection of forty-three Byzantine, Georgian, and Rus'ian enamels. The catalogue is a work of art in and of itself, sumptuously bound in tooled gilded leather with a silk cover and copiously illustrated with custom chromolithographs. The catalogue is so luxurious that its illustrations and overall aesthetic impact have largely overshadowed the content of the text, much to the detriment of scholarship on Byzantine enamels.

While the main goal of the catalogue was to advertise the collection to potential buyers, Kondakov nonetheless produced a detailed overview of *cloisonné* enamel production and a thorough investigation of the most prestigious extant enamels known at the time. Unsurprisingly, one of the primary aims of Kondakov's study was to ascertain the origins of enameling in Byzantium. Focusing on technique, Kondakov located the beginnings of *cloisonné* enameling in ancient Egypt and traced its development through

ancient Greece and its decline in Rome in favor of *champlevé*.[34] Kondakov's study is unique for its ensuing shift in focus from enameling in the European West to enameling in Eastern Europe and the Caucasus, where *cloisonné* was still produced in the Roman period. Following this developmental trajectory of *cloisonné*, Kondakov determined that enameling came to Byzantium from Rome's eastern provinces, supplemented by glass arts imported from Sasanian Persia.[35] Kondakov's eastern orientation is a major departure from both previous and subsequent studies of Byzantine enameling, which have predominantly focused on possible Western origins, and is worth further serious consideration. One of the limitations of Kondakov's study was its limited print run and exclusive distribution. Only two-hundred copies were produced, and Swenigorodskii personally circulated them to influential European and American collectors. The catalogue was never sold to the public and remains on the guarded shelves of a precious few rare book collections. Access to Kondakov's study proved a major obstacle in the historiography of enameling, and his arguments never gained significant traction.

In 1967, Klaus Wessel sought to rectify the absence of an accessible study of Byzantine enamels and created a catalogue of his own. Rather than catering to collectors, Wessel intended his study for the educated enthusiast.[36] Unlike Kondakov, Wessel was not especially interested in how enameling reached Byzantium. Wessel's approach was

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[34] Kondakov, *Geschichte und Denkmäler des byzantinischen Emails*, 6-19.

[35] Kondakov, *Geschichte und Denkmäler des byzantinischen Emails*, 43-73.

[36] Wessel insisted that his study was not for the "small and restricted band of specialists," by which he meant scholars and wealthy collectors. Klaus Wessel, *Byzantine Enamels from the 5th to the 13th Century* (Greenwich, CT: The New York Graphic Society, 1968), 5.

that of the connoisseur, and he selected enamels for inclusion in his catalogue based on their historical significance and aesthetic appeal.[37] He prioritized the clear photographic reproduction of Byzantine enamels and careful assessment of their style and iconography. Wessel's goal was to create a visual timeline, allowing his reader to appreciate an evolutionary perspective on one of Byzantium's most illustrious artforms. Wessel was successful in his endeavor; his study was translated into English the following year, and his timeline remained uncontested until David Buckton's reassessment in the 1980s.

Although David Buckton's major contribution to the study of Byzantine enamel has already been mentioned, it is worth revisiting the importance of his scholarship in the identification and exposure of counterfeits. As a curator of medieval art at the British Museum in the 1980s and 1990s, Buckton focused his scholarly lens on questions of authenticity. Kondakov's and Wessel's publication of high-quality images had the unwelcome consequence of aiding several nefarious dealers in their endeavor to fabricate their own "Byzantine" enamels for sale on the art market.[38] Buckton's curatorial position afforded him access to the most current tools of technical analysis as they developed, and a great majority of his arguments relied on the empirical evidence supplied in

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[37] Wessel, *Byzantine Enamels*, 6.

[38] On the problem of fakes in the history of Byzantine enamel, see David Buckton, "Byzantine Enamels in the Twentieth Century," in *Byzantine Style, Religion and Civilisation: In Honor of Sir Steven Runciman*, ed. Elizabeth Jeffreys (Cambridge: Cambridge University Press, 2006), 25–37; David Buckton, "'Chinese Whispers': The Premature Birth of the Typical Byzantine Enamel," in *Byzantine East, Latin West: Art Historical Studies in Honor of Kurt Weitzmann,* ed. Doula Mouriki (Princeton: Princeton University Press, 1995), 591–96.

collaboration with conservators and research scientists.[39] Additionally, Buckton surveyed collections of Byzantine enamel in Europe and, like Wessel, used style to place them within an evolutionary timeline.[40]

Beginning in the 1980s, Paul Hetherington continued the work of grouping Byzantine enamels based on style, but with the added interest in identifying hands and workshops. A former silversmith turned scholar, Hetherington used his keen technical insight to discern differences in manufacture among Byzantine enamels and incorporated his observations into discussions of style, speculating the existence and grouping of workshops and individual masters.[41] Hetherington also employed his training as a Byzantinist to mine textual sources for information on Byzantine enamel. He turned especially to inventories and aristocratic wills to pose questions about who

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[39] David Buckton, "Bogus Byzantine Enamels in Baltimore and Washington, D.C.," *The Journal of the Walters Art Gallery* 46 (1988): 11–24.

[40] David Buckton, "Byzantine Enamels in Bavaria," *Mitteilungen zur Spätantiken Archäologie und Byzantinischen Kunstgeschichte* 2 (2000): 93–105; David Buckton, "'Early Byzantine' Enamel in France," in *Ritual and Art: Byzantine Essays for Christopher Walter*, ed. Pamela Armstrong (London: Pindar, 2006), 94–105.

[41] For examples of Hetherington's marriage of technical and stylistic analysis, see Paul Hetherington, "Byzantine Enamels for a Russian Prince: The Book-Cover of the Gospels of Mstislav," *Zeitschrift für Kunstgeschichte* 59 (1996): 309–24; Paul Hetherington, "The Byzantine Enamels on the Staurothèque from the Treasury of the Preiuré d'Oignies, Now in Namur (With Excursus: Pearls and Their Association with Byzantine Enamels)," *Cahiers archéologiques* 48 (2000): 1–19; Paul Hetherington, "The Enamels on a Mitre from Linköping Cathedral, and Art in Thirteenth-Century Constantinople," in *Enamels, Crowns, Relics, and Icons: Studies on Luxury Arts in Byzantium* (Farnham: Ashgate, 2008), 1–16.

commissioned, used, and viewed enamels in Byzantium.[42] While best known for his unparalleled close studies of individual enameled objects, Hetherington also tentatively questioned enameling as a Byzantine artistic innovation in a manner similar to Kondakov, but without the strict focus on enameling's origins. Hetherington's prolific research on Byzantine enamels merged stylistic, technical, and textual analysis and initiated an interdisciplinary approach.

Most recently, Bissera Pentcheva has studied Byzantine enamel through the lens of theological metaphor and phenomenological experience. In her reassessment of relief icons in Byzantium, Pentcheva resituated mixed-media enameled objects at the top of a Byzantine material hierarchy and related them to the doctrinal debates and articulation of image theory that dominated the Byzantine periods of Iconoclasm (726 – 787, 814 – 843).[43] According to Pentcheva, the proliferation of enameled icons between the ninth and eleventh centuries corresponded to a new Orthodox understanding of icons as inspirited (ἔμψυχος, *empsychos*) imprints (τύποι, *typoi*) of their divine prototypes, intended to be apprehended and appreciated through the senses as much as the intellect.[44] In her monographic study of Byzantine phenomenological experience, Pentcheva

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[42] For examples of Hetherington's incorporation of textual evidence into the study of Byzantine enamel, see Paul Hetherington, "A Purchase of Byzantine Relics and Reliquaries in Fourteenth-Century Venice," *Arte Veneta* 37 (1983): 9–30; Paul Hetherington, "Enamels in the Byzantine World: Ownership and Distribution," *Byzantinische Zeitschrift* 81 (1998): 29–38; Paul Hetherington, "Byzantine and Russian Enamels in the Treasury of Hagia Sophia in the Late Fourteenth Century," *Byzantinische Zeitschrift* 93 (2003): 133–37.

[43] Bissera Pentcheva, "The Performative Icon," *The Art Bulletin* 88, no. 4 (2006): 631–55.

[44] Pentcheva, "The Performative Icon," 639.

expanded this reading of Byzantine enamels. She discussed their sensuous use of color and radiance as facilitating participation in a Byzantine understanding of materials and representations as active, enlivened agents.[45] Crucially, Pentcheva's approach to enamel represents a departure from pure stylistic or technical analysis, and rather than attempting to group enamels together or date them, Pentcheva considered what enamels may have signified in Byzantine society and how they were experienced by Byzantine viewers.

In the historiography of Byzantine enamels, despite intense scrutiny of style and viewing experience, less attention has been paid to exactly how enamel was made in Byzantium and *what that making meant*. In the present study I shift the focus on Byzantine enamels away from their stylistic or sensual qualities and inquire instead into their epistemic potential, that is, how making Byzantine enamel was a means of learning about the physical world. To do so, I draw my methodology in part from experimental archaeology, in which approaches such as simulation and reconstruction are used to glean information about how artifacts were made and technologies were used.[46] The textual sources that describe enameling and my analysis of the objects themselves are informed by my own production of *cloisonné* enamel from 2017 – 2019 under the supervision of a team of contemporary master goldsmiths and enamellers.[47] In undertaking reconstruction, the goal was not to recreate enamels based strictly on Byzantine recipes, but rather to

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[45] Bissera Pentcheva, *The Sensual Icon: Space, Ritual, and the Senses in Byzantium* (University Park: The Pennsylvania State University Press, 2010), 97–120.

[46] J. M. Coles, *Experimental Archaeology* (London: Academic Press, 1979); Alan K. Outram, "Introduction to Experimental Archaeology," *World Archaeology* 40, no. 1 (2008): 1–6.

[47] For an in-depth discussion of these experimental processes, see Chapter Two.

determine how making enamel is itself a form of learning and a demonstration of that knowledge.

Chapter Overview

Over the course of four chapters, this study argues for the technological power of enamel in medieval Byzantium. The chapters proceed in roughly chronological order, but are primarily arranged thematically. Chapter One establishes the alchemical environment in which enamel developed and provides a brief overview of major historical personages, concepts, and texts in the Byzantine alchemical tradition. I argue for an "artisanal turn" in Byzantine alchemy through the inclusion of long-form treatises on art-making included in the alchemical corpus, and I contend that certain media and artisanal practices, enamel most of all, took on epistemological significance. Chapter Two explores the role of making. I investigate how making enamel was understood to both produce and demonstrate scientific knowledge, and I posit that the knowledge evinced by enamel's "made-ness" was a critical dimension of its aesthetic appreciation. Chapter Three focuses on enamel as a technology of artificial replication, capable of demonstrating human control over natural properties and processes. Through close analysis of the recipes for enameling, I examine how enamel was understood to reproduce wondrous natural phenomena, including the hues and luminosity of gemstones, geological generation, and even the bioluminescence of sea creatures. Chapter Four considers the impact of virtuosity in Byzantine enamel. I argue that the remarkably high level of skill demonstrated in Byzantine enameling was a conscious articulation of power over physical forces, intended to amaze and astound viewers. At the conclusion of each

chapter, I analyze one or more enameled objects according to the chapter's main arguments, elucidating how alchemical concepts manifest in the objects' iconographies, construction, and material compositions.

Chapter One

Art and Alchemy in the Byzantine World

In this dissertation, I propose that Byzantine enameled objects were part of a conceptual system that linked art with technology as instruments of power, and these objects were closely associated with the practice of alchemy. To understand the relationship between enamel and alchemy, it is necessary to establish what constituted alchemy in Byzantium. Alchemy is slippery and difficult to define. Although commonly associated with the creation of gold from base metals, alchemy has encompassed goals as mundane as counterfeiting currency and as far-reaching as the artificial creation of human life.[1] Historically, alchemy was practiced all over the world and across the centuries, resulting in multiple definitions contingent upon specific times and places, and also upon the work of well-known practitioners.[2] To arrive at an useful working

[1] On alchemy and counterfeiting currency, see Maria K. Papathanassiou, "Metallurgy and Metalworking Techniques," in *The Economic History of Byzantium: From the Seventh through the Fifteenth Century*, ed. Angeliki Laiou (Washington, D.C.: Dumbarton Oaks Press, 2002), 121–27. On the *homunculus*, or artificial human, see William R. Newman, *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2004), 164-237. On the achievements of named individuals in the history of alchemy, see Lawrence Principe, *The Secrets of Alchemy* (Chicago: University of Chicago Press, 2013), 107-136.

[2] Monographic surveys of alchemy are rare; it is more common for scholarship to take the form of article-length studies on specific alchemical traditions. However, there are some exceptions. For the most recent surveys of Western European alchemy from antiquity to early modernity, both with concise overviews of alchemical practice in the Arabic-speaking world, see Principe, *The Secrets of Alchemy* and Newman, *Promethean Ambitions*. For Jewish alchemy, see Raphael Patai, *The Jewish Alchemists: A History and Sourcebook* (Princeton: Princeton University Press,

definition of alchemy, it is essential to situate alchemical practices within their temporal and cultural contexts.

This chapter discusses χημεία (*chēmeia*, "alchemy") as practiced in medieval Byzantium, focusing on developments from the ninth through twelfth centuries. Until very recently, the history of alchemy in Byzantium has been subsumed under the headings of "Greek" alchemy, "Greco-Egyptian" alchemy, or "ancient" alchemy.[3] Indeed, Byzantine sources maintain close ties to their ancient and late antique predecessors and often take the form of commentaries on or

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1994). For alchemy in India, see David Gordon White, *The Alchemical Body: Siddha Traditions in Medieval India* (Chicago: University of Chicago Press, 2007). For alchemy in China, see Nathan Sivin, *Chinese Alchemy: Preliminary Studies* (Cambridge MA: Harvard University Press, 1968); Obed Simon Johnson, *A Study of Chinese Alchemy* (Shanghai: Commercial Press, 1928). Surveys of the considerable bodies of medieval alchemical literature in Syriac and Coptic have yet to be written.

[3] An example of this phenomenon is the foundational study of Greek-language alchemy by F. Sherwood Taylor, in which Byzantine contributions to alchemy are characterized as static and unoriginal. See F. Sherwood Taylor, "A Survey of Greek Alchemy," *The Journal of Hellenic Studies* 50, no. 1 (1930): 109–39. More recent studies continue to view Byzantine alchemical writing as useful only insofar as it preserves the works of antiquity and late antiquity, see especially Michèle Mertens, "Graeco-Egyptian Alchemy in Byzantium," in *The Occult Sciences in Byzantium*, ed. Paul Magdalino and Maria V. Mavroudi (Geneva: La Pomme d'or, 2006), 205–30. Exceptions include new surveys in volumes targeted toward the significance of Byzantine contributions to the history of science, for example see Vangelis Koutalis, Matteo Martelli, and Gerasimos Merianos, "Graeco-Egyptian, Byzantine and Post-Byzantine Alchemy: Introductory Remarks," in *Greek Alchemy from Late Antiquity to Early Modernity*, ed. Efthymios Nicolaïdis (Turnhout: Brepols, 2018), 11–44; Cristina Viano, "Byzantine Alchemy, or the Era of Systematization," in *Oxford Handbook of Science and Medicine in the Classical World*, ed. Paul T. Keyser and John Scarborough (Oxford: Oxford University Press, 2018), 943–64.

epitomes of earlier works. However, scholars have tended to view these Byzantine contributions to alchemy as corrupted and inferior reiterations of ideas inherited from classical antiquity, useful only insofar as they can convey "ancient" ideas.[4] This is part of a wider historiographic tendency to see Byzantine cultural production as a vehicle or storeroom for the classical tradition, rather than an original contribution in its own right.[5] As a result, specifically Byzantine aspects of alchemy remain understudied, despite the fact that the majority of Greek alchemical texts survive solely in medieval Byzantine or post-Byzantine manuscripts.

By centering specifically medieval Byzantine contributions to alchemical discourse, I examine attitudes towards matter and its manipulation that have yet to be fully unpacked. Scholars have noted that one of the key features of alchemy in Byzantium is its enthusiastic incorporation of procedures and terminology taken from artisanal production. Still they have not fully questioned the clear, active role that art-making played in Byzantine alchemy. The Byzantine preservation of late antique alchemical theory was part of a larger endeavor to marry that theory with applied practice, and artistic processes became key to articulating complex ideas about the behaviors and properties of physical matter in nature. The proliferation of so-called

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[4] For example, Lawrence Principe laments: "Equally problematic is the fact that the Byzantine compilers chose to copy what *they* thought was important – which could be neither representative of the original texts nor what the original authors themselves would have considered crucial." Principe, *The Secrets of Alchemy*, 12.

[5] Elizabeth Jeffreys. "We Need to Talk about Byzantium: Or, Byzantium, Its Reception of the Classical World as Discussed in Current Scholarship, and Should Classicists Pay Attention?" *Classical Receptions Journal* 6, no. 1 (2014): 158-74. This viewpoint is especially prevalent in studies of scientific contributions, as neatly summarized in Maria Mavroudi, "Translations from Greek into Latin and Arabic during the Middle Ages: Searching for the Classical Tradition," *Speculum* 90, no. 1 (2015): 28–59.

technical treatises alongside the production of commentaries and epitomes is one attestation of this phenomenon: the fusion of τέχνη (*technē*, "art, skill") and λόγος (*logos*, "reason") that is technology. I argue that surviving objects reveal much about how alchemical thought was implemented. This chapter shows that, through alchemy, artistic processes and practices became means of categorizing and demonstrating Byzantine knowledge of the sublunary world. It is in this context that enameling can be understood as an alchemical process in which mundane substances were transformed into new materials that possessed properties not found in their original states.

In acknowledgement that Byzantine alchemy was inextricably intertwined with its late antique predecessors, I first provide an overview of the late antique legacy in Byzantine alchemical writing in order to introduce key names, dates, and concepts that the Byzantines inherited and interpreted. In my discussion of alchemical texts, I focus primarily on two figures, Pseudo-Democritus (fl. first century CE) and Zosimos of Panopolis (fl. fourth century CE), whose contributions to alchemical thought and practice were particularly appreciated by medieval Byzantine authors. In simplest terms, these two authors established a system in which artistic processes took on theoretical and allegorical meaning. In this overview I also identify the genres of "technical treatise," "epitome," and "commentary" as key Byzantine methods for engaging with late antique alchemy. Byzantine authors mined late antique texts and distilled complex multi-volume works into short systematized digests. I turn to these digests for evidence of Byzantine alchemical interests and goals, most of which show a targeted investment in artistic techniques to accomplish the transformation and transmutation of material substances.

I then trace the development of this "artisanal turn" in medieval Byzantine alchemy by examining the introduction of specifically treatises specifying artistic processes to the alchemical

corpus. While late antique authors had established artisanal techniques as methods for exploring the operations of physical matter, Byzantine authors began composing longer-form texts on subjects ranging from goldsmithing to glassmaking and included them in alchemical manuscripts. Unlike their late antique predecessors, the content of these artistic treatises is often not explicitly alchemical. A close look at the texts reveals that some were likely dictated by working artisans themselves. The inclusion of such treatises in Byzantine alchemical compilations points towards a deepening entrenchment of artistic processes in the alchemical tradition, beyond the level seen in late antiquity. I posit that this prioritization of the artistic in medieval Byzantine alchemy indicates a conscious effort to reframe art-making, orienting away from pure production and endowing artistic labor with epistemological power. I contend that works of art became crucial loci for the display of that power.

With new definitions and framings in hand, I return to enamel and analyze one of the earliest Byzantine enameled objects, the Fieschi-Morgan *staurothēkē* ("cross container," or cross reliquary). This reliquary of the True Cross has been subjected to fierce scholarly debate over its provenience and much maligned for its perceived shortcomings in pictorial representation. Accepting a Byzantine provenience and emphasizing the Byzantine definition of enamels as "alchemical things," I turn away from questions of dating and place of production and instead focus on the *staurothēkē* through the lens of Byzantine alchemy. When viewed as an alchemical artifact, the *staurothēkē* reveals new facets of meaning, including the wonder of material change and the power and splendor of transformation.

Late Antique Alchemy in Medieval Byzantium

Before turning to critical names and dates in the Byzantine alchemical tradition, it is necessary to look briefly at how the canon was constituted. The majority of evidence for alchemy in Byzantium takes the form of texts written originally in Greek as early as the first century CE, but which survive solely as later copies in medieval Byzantine or post-Byzantine manuscripts. In the late nineteenth century, French organic chemist Marcelin Berthelot and Hellenist Charles-Émile Ruelle collaborated in collecting, editing, and translating these texts. Known today as the Greek alchemical corpus, their three-volume work, the *Collection des anciens alchimistes grecs* (hereafter *CAAG)*, was published in 1887 and remains the most definitive edition of Greek-language alchemical texts to date.[6] In many ways, Berthelot and Ruelle set the precedent for scholars to value the Greek alchemical corpus as an ancient rather than medieval Byzantine work, because they intentionally restricted their edition and translation to texts that pre-date the eighth century CE. Inclusions of any later texts were predicated on their close relationship to "ancient" works. Thus, some texts present in the manuscripts were excluded from the edition, and others were wrongly dated to late antiquity when they are, in fact, medieval Byzantine in origin.[7]

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[6] Marcellin Berthelot and C.E. Ruelle, eds., *Collection des anciens alchimistes grecs*, 3 vols (Paris: G. Steinheil, 1887).

[7] Berthelot and Ruelle argued for ending their study with the rise of alchemy in Arabic, see *CAAG* I:xi-xiii. On the misdating of Byzantine alchemical texts, see Olivier Dufault, "Transmutation Theory and the Dating of the Alchemical Recipe 'On the Same Divine Water,'" in *Prote Hyle: Notions of Matter in the Platonic and Aristotelian Traditions*, ed. Andrea Le Moli and Leila Alexidze (Palermo: Palermo University Press, 2017), 67-84; Jean Letrouit,

Berthelot and Ruelle collated the Greek alchemical corpus from three principle medieval manuscripts. The oldest, Biblioteca Marciana gr. 299, dates between the tenth and eleventh century and is arguably the most famous Byzantine alchemical manuscript.[8] Compiled by Theodore, presumably an imperial courtier or court official, it consists of numerous foundational and theoretical texts on alchemy followed by a series of technical operations.[9] Some scholars have dated the original compilation by Theodore to the reign of emperor Heraclius (r. 610 – 641) and have judged the manuscript to be a later copy, while others have argued that Theodore's compilation is contemporary to the manuscript itself.[10] The contents of the manuscript are concerned primarily with χρυσοποιία (*chrysopoiia*, chrysopoeia or "gold-making"); treatises on

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"Chronologie des alchimistes grecs," in *Alchimie: Art, histoire et mythes. Actes du 1er colloque international de la Société d'Étude de l'Histoire de l'Alchimie (Paris, Collège de France, 14-15-16 mars 1991)*, ed. D. Kahn and S. Matton (Paris: S.E.H.A.; Milan: Arché, 1995), 11-94.

[8] H.D. Saffrey, "Historique et description du manuscrit alchimique de Venise Marcianus Graecus 299," in *Alchimie: Art, histoire et mythes. Actes du 1er colloque international de la Société d'Étude de l'Histoire de l'Alchimie (Paris, Collège de France, 14-15-16 mars 1991)*, ed. D. Kahn and S. Matton (Paris: S.E.H.A.; Milan: Arché, 1995), 1–10.

[9] For a translation and commentary on the manuscript's verse dedication, see Saffrey, "Historique et description," 8-9.

[10] The manuscript's original table of contents attributes four treatises to the emperor Heraclius and two to his predecessor Justinian I (r. 527 – 565), which were at some point intentionally removed from the binding and discarded. The dating of the compilation to Heraclius' reign depends partially on the presence of these treatises, but also on the dating of the texts that comprise the manuscript. None appear to be later than the eighth century CE based on the content and proper names mentioned in the texts themselves. The dating of the copying of the manuscript to the tenth or eleventh century is based on paleography. See Saffrey, "Historique et description," 5-6, 9. For a later dating of Theodore's compilation to the eleventh century, see Letrouit, "Chronologie des alchimistes grecs," 86-87.

dream interpretation, agriculture, and astrology were inserted at a later date.[11] The second oldest manuscript, Paris gr. 2325, dates to the thirteenth century and derives at least in some part from Marciana gr. 299.[12] The third manuscript, Paris gr. 2327, is a post-Byzantine work dated to 1478 and copied on Crete by a scribe from Corfu named Theodore Pelekanos.[13] Paris gr. 2327 is more or less also a copy of Marciana gr. 299 though it contains a number of texts found in neither Marciana gr. 299 nor Paris gr. 2325. Although Berthelot and Ruelle augmented their edition with a further nine auxiliary manuscripts, these three medieval codices form the backbone of the alchemical corpus and help to establish its core repertoire of authors and subjects.

Alchemy in medieval Byzantium was an antiquarian practice with roots in the alchemical traditions of classical antiquity and late antiquity. As previously mentioned, this indebtedness should not be mistaken for a lack of original thought, but rather indicates a respect for the authority of the past. Byzantine alchemical authors created a dialogue with their predecessors, whom they called παλαιοί (*palaioi*, "ancients") and φιλοσοφοῖ (*philosophoi*, "philosophers").[14]

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[11] For example, an additional quire was added with a treatise on the dreams of Nikephoros, Patriarch of Constantinople (fl. 806 – 815), selections of the tenth-century *Geoponika*, and astrological tables. This quire was eventually bound together with the rest of the manuscript. See Saffrey, "Historique et description," 2.

[12] For a comprehensive account of the alchemical manuscript tradition, see Letrouit, "Chronologie des alchimistes grecs," 12-14.

[13] Marcellin Berthelot, *Les origines de l'alchimie* (Paris: G. Steinheil, 1885), 96, 376; Robert Halleux, *Les textes alchimiques* (Turnhout: Brepols, 1979), 60–62; Mertens, "Graeco-Egyptian Alchemy in Byzantium," 205–30; Gerasimos Merianos, "Alchemy," in *The Cambridge Intellectual History of Byzantium*, ed. Anthony Kaldellis and Niketas Siniossoglou (Cambridge: Cambridge University Press, 2017), 235.

[14] As seen in titles of alchemical texts, such as *Περὶ τοῦ ὠοῦ οἱ παλαιοί φασιν οὕτως* (*Peri tou ōou oi palaioi phasin outōs*, "Concerning How the Ancients Speak of The Egg") and *Περὶ*

Although contemporary scholars have contended that Byzantine interest in alchemy focused primarily on chrysopoeia, a close look at the relationship between Byzantine and late antique alchemy reveals a much more complex practice. Byzantine alchemical authors, both anonymous and named, delved into specialized knowledge preserved from earlier centuries on subjects as varied as the coloration and nature of metals, the qualities of material substances, and a wide range of technical operations, such as distillation.

Foremost, the texts of the Byzantine alchemical manuscripts evoke a conversation between their compilers and past thinkers concerning the behavior and operations of physical matter, its composition, its transformation, and its ultimate perfection. This conversation took place primarily in the composition and standardization of particular textual formats. The "technical operation" (or "recipe"), the "epitome" (or summary), and the "commentary" represent three of the most common Byzantine interventions into alchemical discourse. Perhaps the most pervasive of these textual formats is the recipe.[15] In late antiquity, the recipe became a means of systematizing certain types of information. The recipe is best characterized by the contents of the earliest extant alchemical papyrus codices, the Leiden and Stockholm papyri.[16]

συνάξεως τῶν φιλοσόφων (*Peri synaxeōs tōn philosophōn*, "Concerning Assembly of the Philosophers"). *CAAG* II:35-36.

[15] On the earliest iterations of technical operations (or recipes), see Mark Clarke, "The Earliest Technical Recipes: Assyrian Recipes, Greek Chemical Treatises and the Mappae Clavicula Text Family," in *Craft Treatises and Handbooks: The Dissemination of Technical Knowledge in the Middle Ages*, ed. Ricardo Córdoba (London: Brepols, 2013), 9-32.

[16] Robert Halleux, ed., *Les alchimistes grecs: papyrus de Leyde, papyrus de Stockholm, fragments de recettes*, vol. 1 (Paris: Belles Lettres, 1981). As Radcliffe Edmonds rightly notes, the papyri straddle the boundary dividing alchemy from magic: the Leiden and Stockholm papyri were unearthed together with other papyrus codices of the so-called Greek Magical Papyri and

These two papyri date to the third century CE and contain numerous instructional formulas for coloring and alloying metals and for the creation of gemstones and pearls. Often short and abbreviated, the formulas presuppose familiarity with materials and their processing. They represent an attempt to collect and categorize knowledge derived from artisanal and industrial practice. Though the exact contents of the Leiden and Stockholm papyri do not appear in Byzantine manuscripts, the recipe format they helped to establish enjoyed wide popularity well into the Middle Ages.

The Byzantine epitome extracted and excerpted portions of larger works in an endeavor to systematize certain types of knowledge. In this respect, it functioned much like a recipe. Yet Byzantine alchemical epitomes were longer and more structured, often composed of multiple recipes together with theoretical excurses. Finally, the Byzantine alchemical commentaries tend to take the form of dialogues or doxographies (collections of commonly-held viewpoints). All three formats – recipe, epitome, and commentary – work to collate and streamline different currents of alchemical thought and establish a sophisticated, multifaceted body of specialized knowledge.[17] I turn to these texts to interpret Byzantine priorities within alchemical practice.

The specialized knowledge that made up Byzantine alchemy had its own lineage. Citations and pseudonymous writings dating between the first and third centuries CE were traced back to Hermes, Isis, Cleopatra, and Moses, among other ancient figures of occult knowledge.[18] Some figures gained particular prominence through their areas of expertise. For example,

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appear written in the same hand as more explicitly magical texts. Radcliffe G. Edmonds, *Drawing Down the Moon: Magic in the Ancient Greco-Roman World* (Princeton: Princeton University Press, 2019), 273–75.

[17] Viano, "Byzantine Alchemy," 943–64.

[18] On pseudepigraphy in Byzantine alchemy see Halleux, *Les textes alchimiques*, 97–100.

Byzantine commentators hailed Maria, a Jewish woman, as the inventor of furnaces and distillation apparatuses.[19] The Persian sorcerer Ostanes was credited with bringing knowledge of matter's transformation to Egypt, where he purportedly took on students as renowned as Pythagoras, Plato, and Alexander the Great.[20] Later Byzantine compilers counted the emperors Justinian I (r. 527 – 565) and Heraclius (r. 610 – 641) among alchemical experts, eliding alchemical knowledge with imperial power. Two names stand out from this legendary cohort as the most prominent alchemical authors in the Byzantine tradition: Pseudo-Democritus (fl. first century CE) and Zosimos of Panopolis (fl. fourth century CE).

Democritus was a name associated with the ancient atomist Democritus of Abdera (c. 460 – 370 BCE). Though the authentic works of Democritus of Abdera are fragmentary and few, his authority was co-opted by one or, more likely, several authors in late antiquity who wrote pseudonymously under his name.[21] Sometime in the first century CE, one or more authors writing under the name Pseudo-Democritus composed four books, one each on the making of gold, silver, purple dye, and gemstones – an encyclopedic enterprise that anticipates the Leiden and Stockholm papyri.[22] What survives of the original *Four Books* are two Byzantine epitomes titled *Περὶ ασήμου ποιήσεως* (*Peri asēmou poiēseōs*, "On the Making of Silver"), and *Δημοκρίτου περὶ πορφύρας καὶ χρυσοῦ ποιήσεως· φυσικὰ και μυστικά* (*Dēmokritou peri*

[19] Raphael Patai, "Maria the Jewess - Founding Mother of Alchemy," *Ambix* 29, no. 3 (1982): 177–97.

[20] Pliny the Elder, *Natural History*, Bk. 30, Ch. 2.

[21] On the authorship of the *Four Books* and their attribution to Democritus of Abdera, see Matteo Martelli, ed., *The Four Books of Pseudo-Democritus* (Leeds: Maney Publishing, 2013), 32–44.

[22] On the dating of the *Four Books* and their composition to the reign of Nero, see Martelli, *The Four Books of Pseudo-Democritus*, 29-31.

porphyras kai chrysou poiēseōs: physika kai mystika, "Democritus On the Making of Purple and Gold, Natural and Secret Questions"), commonly known as the *Physika kai Mystika*. The *Four Books* and their epitomes received a lively reception, as witnessed by an extant commentary and many citations in the alchemical corpus.[23] It is the *Physika kai Mystika* that formed a foundation for later Byzantine alchemical works by building a theory around practical expertise. Recipes make up the bulk of the *Physika kai Mystika*. A typical recipe for making gold reads as follows:

> Make cinnabar white with oil, or vinegar, or honey, or brine, or alum; then make it yellow with *misy*, or *sōri*, or copper flower, or unburnt sulfur, or according to your knowledge. So lay it on silver: and it will be gold, if you dip gold [into the solution?]; if you dip copper, [it will be] electrum. For nature conquers nature.[24]

Much like the Leiden and Stockholm papyri, the *Physika kai Mystika* collects and organizes artisanal knowledge, as in the above example, which discusses a method for gilding silver. Long lists of materials are common, as are terse directives on how to process them. This feature is

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[23] The *Four Books* are the subject of an extant commentary, Συνεσίου φιλοσόφου προς Διόσκορον εἰς τὴν βίβλον Δημοκρίτου ὡς ἐν σχολίοις (*Synesiou philosophou pros Dioskoran eis tēn biblon Dēmokritou ōs en scholiois*, "The Philosopher Synesius to Dioscorus: Notes on Democritus' Book"), and was the subject of commentaries by the alchemical author Petasius, now preserved only in citations elsewhere in the alchemical corpus. The citations of the *Four Books* and their epitomes within the alchemical corpus are too numerous to be listed and could easily form the subject of their own study. On the commentary of Synesius and the citations of Petasius, see Martelli, *The Four Books of Pseudo-Democritus*, 50-54.

[24] Τὴν κιννάβαριν λευκὴν ποίει δι' ἐλαίου, ἢ ὄξους, ἢ μέλιτος, ἢ ἅλμης, ἢ στυπτηρίας, εἶτα ξανθὴν διὰ μίσυος, ἢ σώρεως, ἢ χαλκάνθου, ἢ θείου ἀπύρου, ἢ ὡς ἐπινοεῖς. Καὶ ἐπίβαλλε ἀργύρῳ, καὶ χρυσὸς ἔσται, ἐὰν χρυσὸν καταβάπτῃς· ἐὰν χαλκὸν, ἤλεκτρον. Ἡ φύσις τῇ φύσει τέρπεται. Trans. Martelli, *The Four Books of Pseudo-Democritus*, 90-91.

apparent in the above quotation, in which whitening ingredients and yellowing ingredients are listed, and very brief instructions for how to use them are provided. Where the *Physika kai Mystika* diverges from the papyri is in its development of a theoretical framework and historical narrative for alchemy. The simple axiom that closes the recipe, "nature conquers nature," hints at the larger cosmology built into the works of Pseudo-Democritus, which permeates later Byzantine writing.

Like Pythagoras, Plato, and Alexander, Democritus, too, was reputed to be a student of Ostanes.[25] Amidst the recipes in the *Physika kai Mystika*, Pseudo-Democritus recounts his training under the Persian master. He tells of how the secrets of alchemy were transmitted following his teacher's death:

> We worked very hard to make substances and natures mix together and bring them into aggregation. When we accomplished the combinations of the matter, after a little while a feast took place in the temple and all of us joined in the banquet. We were in the *sancta sanctorum* when a column broke up by itself, which at first sight did not contain anything inside. But <…> said that the books of his father [i.e. Ostanes] had been preserved within this column, and he took them out and showed them publicly. Peering [into the books] we were surprised [to find] that we had not neglected anything, except this very helpful saying that we found there: "Nature delights in nature, nature conquers nature, nature masters nature." We marveled greatly at how he had summarized all his work in such a short saying.[26]

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[25] Martelli, *The Four Books of Pseudo-Democritus*, 2-3.

[26] …δεινὸν ὑπέστημεν κάματον ἔστ' ἂν συνουσιωθῶσι καὶ συνεισκριθῶσιν αἱ οὐσίαι καὶ αἱ φύσεις. Ὡς δὲ ἐτελειώσαμεν τὰς συνθέσεις τῆς ὕλης, χρόνου τινὸς ἐνστάντος καὶ πανηγύρεως οὔσης ἐν τῷ ἱερῷ, πάντες ἡμεῖς εἰσθιώμεθα· ὡς οὖν ἦμεν ἐν τῷ ναῷ ἐξ αὐτομάτου στηλή τις ἠ κίων ἦν, ἣ διαρρήγνυται, ἣν ἡμεῖς ἐωρῶμεν ἔνδον οὐδὲν ἔχουσαν. Ὁ δὲ οὔτ'ἄν τις ἔφασκεν, ἐν

In this passage, Pseudo-Democritus explains that after his master died, he and other students attempted to transmute substances without his guidance. When they succeeded, they celebrated, and during their celebration the master's books revealed themselves and imparted his wisdom. Elements of the short saying "nature delights in nature, nature conquers nature, nature masters nature" punctuate each of the recipes in the *Physika kai Mystika*. In whole, the axiom sets forth a system by which alchemy was understood to operate. It describes the sympathies and antipathies of matter, or, as Radcliffe Edmonds has observed, explains the means by which substances assume certain physical qualities.[27] When like substances meet, they "delight" in each other and display their shared qualities. When different substances meet, a hierarchy determines which qualities matter takes on. In the aforementioned recipe, a mixture of substances with the quality of yellowness are applied to silver or copper, and the yellow quality of gold is able to "conquer" the silver's whiteness or the copper's redness. There are no recipes for turning gold into silver, or silver into copper. Matter can only progress towards a more perfect state. While the short saying appears to be simple, it actually communicates a complex theory for how the recipes in the epitome worked. It also articulates a goal, that is, the mastery of nature. Cast in this light, the artistic techniques included in the recipes do not serve a purely practical application; they also function as demonstrative proof of certain philosophical principles. The inclusion of the axiom's

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αὐτῇ τὰς πατρώας τεθησαυρίσθαι βίβλους, καὶ προκομίσας εἰς μέσον ἤγαγεν. Ἐγκύψαντες δὲ ἐθαυμάζομεν ὅτι μηθὲν, ἦμεν παραλείψαντες, πλὴν τοῦτον τὸν λόγον εὕρομεν ἐκεῖ πάνυ χρήσιμον. Ἡ φύσις τῇ φύσει τέρπεται, καὶ ἡ φύσις τὴν φύσιν νικᾷ, καὶ ἡ φύσις τὴν φύσιν κρατεῖ. Ἐθαυμάσαμεν πάνυ ὅτι ἐν ὀλίγῳ λόγῳ πᾶσαν συνήγαγε τὴν γραφήν. Trans. Martelli, *The Four Books of Pseudo-Democritus*, 83-84.

[27] Radcliffe G. Edmonds, *Drawing Down the Moon*, 284–85.

discovery in the Byzantine epitome is no accident. The framing of technique as epistemology – that is to say, making as knowing – was crucial to medieval Byzantine alchemical thought and practice.

Perhaps the most celebrated alchemical author in the Byzantine tradition was Zosimos of Panopolis. The ninth-century CE *Suda* lexicon includes an entry for Zosimos, noting that he wrote twenty-eight volumes on the subject of alchemy dedicated to his sister, Theosebia, as well as an account of the life of Plato.[28] Zosimos' writings exist in a fragmentary state, and though they were likely composed in the early fourth century CE, they were subsequently distributed as epitomes and commentaries for centuries.[29] The best known and most copied of his works is the *Γνήσια ὑπομνήματα* (*Gnēsia hypomnēmata*, "Authentic Memoirs"), an epitome comprised of thirteen short excerpts, including a set of texts known by the contemporary title *Visions*.[30] In the *Visions*, Zosimos recounts a series of dreams in which the materials of alchemical practice, mostly metals, assume human form. These personifications undergo dismemberment, torture, and boiling upon an altar in the shape of an alchemical apparatus.[31] Scholars have interpreted the *Visions* as an attempt to develop a system of mystical alchemy, in which alchemical processes are allegories for methods of liberating the soul from the body or elevating the soul to the level

[28] David Whitehead, trans., "Zosimos," *Suda* Online. http://www.stoa.org/sol-entries/zeta/168. Accessed July 18, 2019.

[29] For an introduction to Zosimos and his reception in later Byzantium, see Mertens, "Graeco-Egyptian Alchemy in Byzantium," 209-15.

[30] For a comprehensive overview of the extant works of Zosimos of Panopolis, the history of their transmission, and an outline of their contents, see Michèle Mertens, *Zosime de Panopolis, Mémoires authentiques* (Paris: Les Belles Lettres, 1995), xi-cxii.

[31] Mertens, *Mémoires authentiques*, 10-12.

of the divine.[32] That is to say, the works of Zosimos set forth a model in which the soul undergoes processing with the eventual goal of perfection, just in the same manner as physical matter.[33]

However, as Matteo Martelli observes, the majority of Zosimos' extant work diverges from the *Visions* and deals instead with technical operations.[34] In many cases, Zosimos himself extracts and quotes his predecessors. Martelli notes that Zosimos seems particularly occupied with identifying the true meanings of named materials in technical procedures, which he regards as existing veiled in secrecy and code.[35] Zosimos' writings are organized around themes of revelation, that the true nature of both matter and the soul can be revealed through the correct processes.[36] The common feature to both of Zosimos' mystical and technical strands of

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[32] Cristina Viano, "Alchemy," in *The Encyclopedia of Ancient History*, ed. Roger S. Bagnall, Kai Brodersen, Craige B. Champion, Andrew Erskine, and Sabine R. Heubner (Malden, MA: John Wiley & Sons, Inc., 2013), 2; Matteo Martelli, "Greco-Egyptian and Byzantine Alchemy," in *A Companion to Science, Technology, and Medicine in Ancient Greece and Rome*, ed. Georgia L. Irby (Hoboken: Wiley-Blackwell, 2016), 217–31; Merianos, "Alchemy," 234–51.

[33] Interpreting the spiritual dimensions of alchemical practice has proved especially challenging for scholars because, as Edmonds notes, "none of the evidence, however, ever explains precisely how the analogy works, and the connection between physical processes and mystical purification of the soul is never made explicitly," 275. Edmonds provides an elegant summary of the spiritual or mystical dimensions of Zosimos' works, particularly their participation in the Platonic philosophical tradition. See Edmonds, *Drawing Down the Moon*, 297–304.

[34] Martelli, "Greco-Egyptian and Byzantine Alchemy," 226-27.

[35] Martelli, "Greco-Egyptian and Byzantine Alchemy," 227.

[36] The Syriac tradition of Zosimos' writings records that angels handed down the first books on alchemy to human beings, linking Zosimos' alchemical practice to divine revelations. See Koutalis, Martelli, and Merianos, "Graeco-Egyptian, Byzantine and Post-Byzantine Alchemy," 11–44.

alchemical thinking is the importance of process as the means by which the practitioner arrives at his goal.[37] This feature helps to explain the later Byzantine interest in and preservation of Zosimos' works outside of the *Visions*. Unlike Pseudo-Democritus, Zosimos does not establish a theory for alchemy, but rather puts forth the possibility that alchemy functions allegorically as a whole.[38]

Together the works of Pseudo-Democritus and Zosimos of Panopolis create a paradigm in which technical processes have an underlying theoretical and allegorical potential. Because this paradigm prioritizes process and procedure, it sets up an environment in which the results of alchemical practice can also be read for the concepts they embody. This allows for a reading of extant objects as alchemical artifacts. With much of alchemical practice derived from artisanal labor, this means that art-making assumed meaning beyond the basic production of physical images and objects, that is to say, art-making became conceptual and works of art became proof of specific concepts. The emphasis on this paradigm by later Byzantine authors marks a shift in what it meant to make art. I propose that art-making itself became a tool for investigating matter, whether literal, physical matter, or matter as an allegory. As a result, the finished product advertised, reified, and materialized that knowledge.

The "Artisanal Turn" in Medieval Byzantine Alchemy

On folio 188 *verso* of Biblioteca Marciana gr. 299, a group of stark, linear illustrations are spread out across the page (Fig. 12). To the left side, a serpent swallows its own tail, a representation

[37] Olivier Dufault, "Transmutation Theory in the Greek Alchemical Corpus," *Ambix* 62, no. 3 (2015): 215–44.

[38] Dufault, "Transmutation Theory," 242.

known as an *ouroboros.* The brief text inside the ring of its body reads ἕν το πάν (*hen to pan*, "one [is] all"), an abbreviation of the longer alchemical aphorism in the rings above its head. To the right side is a distillation apparatus with all its parts carefully labeled. A smattering of crescents and small depictions of furnaces and crucibles frame the *ouroboros* and the apparatus. Across the top runs the heading κλεοπάτρης χρυσοποιΐα (*kleopatrēs chrysopoiia*, "Cleopatra's Gold-Making"), designating that this group of illustrations represents a procedure ascribed to Cleopatra. The accompanying text, however, is not authored by that legendary alchemist, but is instead the *Authentic Memoirs* of Zosimos.[39]

The late fifteenth-century Paris gr. 2327 is also lavishly illustrated, mostly with depictions of distillation apparatuses and furnaces. Perhaps the most dramatic and, like the illustrations of Marciana gr. 299, most often reproduced, is the splendid representation of a bright red and green *ouroboros* on folio 279 *recto* (Fig. 13). The dragon-like serpent eagerly devours its own tail as it makes eye contact with the viewer. Unlike Marciana gr. 299, however, this *ouroboros* loops through the text of two alchemical riddles on the subject of the *ouroboros*, which is ultimately a symbol of the unity of primordial matter.[40]

Although often reproduced in scholarly publications and popular "New Age" books, the illustrations have received little in-depth study. It is beyond the scope of this project to explicate all of their iconography, decode their inscriptions, or unpack their relationship to the dense texts that surround them. However, the images are intriguing in a way that has implications for the study of enamel precisely because they provide strong evidence that Byzantine thinkers used

[39] Saffrey, "Historique et description," 6.

[40] H. J. Sheppard, "The Ouroboros and the Unity of Matter in Alchemy: A Study in Origins," *Ambix* 10, no. 2 (1962): 83–96.

artistic representation to think through alchemical ideas. The *scholia* in the margins of Paris gr. 2327 insist as much. To the right of the *ouroboros* is a short exclamation, Σὺ δὲ ἐν τούτοις τὸν νοῦν ἔχων, ὦ φίλτατε (*Su de en toutois ton noun echōn, ō philtate*, "Make sure you pay attention to this, my friend!"), with its rubricated *sigma* echoing the serpent's curves. These representations make a case for the possibility that art conveyed alchemical meaning as surely as text.

When Berthelot and Ruelle compiled the Greek alchemical corpus, they divided the texts first by author and then thematically. One grouping of texts, which has received little scholarly attention compared to others, is labeled *Traités techniques*, "Technical Treatises." All of them have been dated as "later" (i.e., Byzantine) than texts with named authors or pseudonymous texts.[41] Only a few examples have been studied individually, and scholars have never considered the appearance of technical treatises as a phenomenon on its own terms.[42] Where and when the

[41] It should be noted, however, that the technical treatises were included in the alchemical corpus based on their "recollection" of "ancient Egyptian" recipes, see Berthelot, *Les origines de l'alchimie*, 122-23.

[42] Two exceptions are texts known as *The Work of the Four Elements* and *On the Most Honorable and Renowned Goldsmith's Art*. On *The Work of the Four Elements*, see Andrée Colinet, "*Le travail des quatre éléments* ou lorsqu'un alchimiste byzantin s'inspire de Jabir," in *Occident et proche-orient: Contacts scientifiques au temps des croisades. Actes du colloque de Louvain-La-Neuve, 24 et 25 Mars 1997*, ed. Isabelle Draelants, Anne Tihon, and Baudouin Van Den Abele (Turnhout: Brepols, 2000), 165–90. For *On The Most Honorable and Renowned Goldsmith's Art*, see Jochem Wolters, "Der byzantinische Traktat über die Edle und Hochberühmte Goldschmiedekunst aus dem 11. Jarhundert," in *Schatzkunst am Aufgang der Romanik: Der Paderborner Dom-Tragaltar und sein Umkreis*, ed. Christoph Stiegemann and Hiltrud Westermann-Angerhausen (Munich: Hirmer Verlag, 2006), 259–84; Antje Bosselmann-Ruickbie, "Das Verhältnis der *Schedula diversarum artium* des Theophilus Presbyter zu

technical treatises appear, as well as the combined nature of their contents, has never been examined. My systematic evaluation has determined that the subjects of the treatises are often identifiable as artistic processes. Unsurprisingly, most relate to metallurgy and metalworking, but included among the treatises are tracts on how to make glass, how to color and treat stones, how to make pearls, and how to dye cloth. Many of the passages are idiosyncratic and contain evidence that they were sourced from artisans themselves, which is a departure from the systematic and encyclopedic treatment of artisanal processes in late antiquity. It is in these treatises that instructions for enameling appear. By analyzing the technical treatises as a discrete Byzantine phenomenon, I contextualize making enamel within a wider reframing of artistic labor as epistemologically meaningful. I consider the technical treatises alongside completed objects, outlining the goals of Byzantine alchemy and providing new readings that take into account the meaning of the objects' production.

The primary goal of alchemy is the creation of gold through the transmutation of baser metals. The technical treatises include two works on goldsmithing, titled *Περὶ τῆς τιμιωτάτης καὶ πολυφήμου χρυσοχοϊκῆς* (*Peri tēs timiōtatēs kai polyphēmou chrysochoikēs*, "On the Most Noble and Renowned Goldsmiths' Art") and *Διαφοραὶ μολίβδου καὶ χρυσοπετάλου* (*Diaphorai molibdou kai chrysopetalou*, "Differences of Lead and Gold Leaf"). Jochem Wolters dated *On the Most Noble and Renowned Goldsmith's Art* to the eleventh century.[43] The treatise contains fifty-seven chapters and sixty-nine recipes and appears in the fifteenth-century Paris gr. 2327.

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byzantinischen Goldschmiedearbeiten: Grenzüberschreitende Wissensverbreitung im Mittelalter?" in *Zwischen Kunsthandwerk und Kunst: Die "Schedula diversarum artium,"* ed. Andreas Speer, Maxime Mauriège, and Hiltrud Westermann-Angerhausen (Cologne: de Gruyter, 2013), 333–68.

[43] Wolters, "Der byzantinische Traktat," 259.

The recipes range from how to gild silver to enameling to how to create solder, and the treatise has all the appearances of a workshop handbook. *Differences of Lead and Gold Leaf* has only been studied peripherally, but it appears in all three alchemical manuscripts, and its inclusion in Marciana gr. 299 indicates a possible date as early as the tenth century.[44] It contains only seven chapters, most dealing with exact proportions of materials needed to create alloys, produce gold leaf, and, in one case, gild the chancel screen and ciborium of an oratory.[45] Like *On the Most Noble and Renowned Goldsmith's Art, Differences of Lead and Gold Leaf* appears to be workshop notes or at least the dictation of a working artisan.

At first glance the inclusion of the two treatises in the alchemical manuscripts seems straightforward. They ostensibly treat the subject of gold. However, rather than the *creation* of gold itself, these texts deal with gold *processing*. While the difference is subtle, in earlier texts, such as the Leiden and Stockholm papyri or even the *Physika kai Mystika*, the focus is on making substances take on the qualities of gold. In *On the Most Noble and Renowned Goldsmiths' Art* and *Differences of Lead and Gold Leaf*, gold, silver, and copper already exist, and are instead manipulated in a variety of artisanal ways – that is to say, they are transformed into objects rather than substances. In fact, in *Differences of Lead and Gold Leaf*, the author lists the exact amounts of metal for making objects, as follows:

> For a gold object, coin [is spread] 7 cubits, a mixture of *misy* [copiapite], old tin, and Indian wormwood.[46]

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[44] Papathanassiou, "Metallurgy and Metalworking Techniques," 121–27.

[45] *CAAG* III:362-64.

[46] Ἐπὶ χρυσολίθου Νο α′ πηχῶν ζ′, μίξεως μύσεως, κασσιτέρου παλαιοῦ, ἀρτεμισίας ἰνδικῆς. *CAAG* III:378.

Instead of discussing how to make one substance take on the quality of another, this treatise dictates how to take gold that already exists in coin form (or possibly ingots intended for coin), alloy it, and stretch it into sheets for forming. The shift here is that, by way of the inclusion of these treatises in alchemical manuscripts, alchemy now encompasses the creation of objects as well as substances.

This shift has implications for exquisite objects such as a tenth- or eleventh-century *calyx* (chalice) now in the Cleveland Museum of Art (Fig. 14). Deep, richly veined blood jasper or heliotrope forms the cup of the *calyx*, which is entirely encased in an armature of gilded copper. The question arises as to why copper was chosen for such a luxurious object, when many similar Byzantine vessels were framed with gilded silver or gold itself.[47] Even though the copper on the *calyx* is gilded, its owner would most likely have been aware that it was copper underneath because most patrons in the Middle Ages were well informed of the material composition of the objects they commissioned.[48] One explanation is that copper was more economical. However, the amount of copper is relatively minimal in comparison to the large, presumably expensive, semi-precious stone it frames, suggesting that economy was not a primary motivation for the patron. Another possibility is that gilded copper appealed to viewers who knew it was gilded, that is, who knew that it had been transformed through alchemical processes. Its material allure derived from its visual properties, but also from its transmutated state. Here *On the Most Noble and Renowned Goldsmith's Art* offers clarity. Recipes for gilding copper are interwoven with a

[47] See the discussion of comparable objects in the Treasury of San Marco in Chapter Three.

[48] See for example, Joseph S. Ackley, "Copper-Alloy Substrates in Precious-Metal Treasury Objects: Concealed and Yet Excessive," *Different Visions: A Journal of New Perspectives on Medieval Art* 4 (2014): 1–34.

series of more explicitly "alchemical" recipes for mysterious substances such as "Divine Water," a type of liquid sulfur or mercury used in aurification (processes that involve the working of gold).[49] Wolters has argued that these alchemical recipes in *On the Most Noble and Renowned Goldsmith's Art* are later additions, but a more compelling interpretation is that Byzantine authors were "alchemizing" ordinary artistic techniques by assimilating them with more explicitly alchemical content. In this scenario, the gilded copper of the *calyx*'s frame becomes an extraordinary material that has undergone a transmutation of its qualities with the aid of human expertise. Rather than a cheap imitation of gold, the gilded copper is something as remarkable as gold itself, because for all intents and purposes it *is* gold. It is, however, *made* instead of mined, and its making is an alchemical act.

The technical treatises also include a brief account on how to make crystal of different colors using the whites and yellows of egg and the blood of small black birds.[50] Berthelot and Ruelle note that the recipe, which begins with the calcination of eggshells, had been altered in Marciana gr. 299 to include even further instructions on sublimating oils associated with colored crystals to create gold, thereby fully "alchemizing" a technical recipe. The focus of the recipe is no longer the manipulation of mineral substances but rather the transformation of substances from one to another. Like the gilded copper *calyx*, Byzantine glass gems that seemingly imitate precious stones take on more nuance. The British Museum houses one such gem in the form of a cameo, molded from glass paste in the shape of a medallion with the bust of Christ (Fig. 15). The deep blue glass resembles sapphire or perhaps chalcedony, a popular stone used in Byzantine cameos as seen in an eleventh- or twelfth-century example now in the Metropolitan Museum of

[49] *CAAG* III:326, 332-33.

[50] *CAAG* III:349-50.

Art (Fig. 16). Through alchemy, the act of making glass "stones" could convey notions of transformation, concepts that correspond well with representations of Christ, who himself was transformed from divine to human to divine again.

As such, the significance of alchemical processes may have assumed spiritual dimensions, suggesting that transmuted materials were especially relevant to certain iconographic themes. I posit, for instance, in the same way that alchemy transformed base matter into perfected crystal or gold, so too did Christ transform death to life through his resurrection. The artisanal turn in Byzantine alchemy allowed for the application of new layers of meaning to the materials of objects, which were no longer ordinary matter but matter that had changed and become supernaturally and epistemologically charged.

One object with the potential for an alchemical reading is a magnificent tenth-century *artophorion* (a container for the eucharist), which was later adapted to serve as a reliquary of Saint Anastasios the Persian; it is now preserved in the treasury of Aachen Cathedral (Fig. 17).[51] Modeled in the shape of a chapel, the *artophorion* is constructed from gilded silver sheet and inlaid with niello (a black inlay of silver and lead sulfide). Unlike the copper frame of the blood jasper *calyx*, the *artophorion* is only partially gilded, allowing the viewer to marvel at how it

[51] The *artophorion* was commissioned in 969 or 970 by the aristocratic military official Eustathios Maleïnos, whose name appears in an inscription on the object. Scholarly consensus has long held that it was originally an *artophorion* and later a reliquary, an interpretation which I endorse. However, Mabi Angar has recently suggested that the object was created and always functioned as a reliquary. See Mabi Angar, *Byzantine Head Reliquaries and Their Perception in the West after 1204: A Case Study of the Reliquary of St. Anastasios the Persian in Aachen and Related Objects* (Wiesbaden: Harrassowitz Verlag, 2017), 23-120.

appears to be made seamlessly of two materials – silver and gold. Nielloed heart-shaped vegetal tendrils frame the doors to the reliquary and the lobes of its dome and semi-dome (Fig. 18).

The combination of gilding and niello recalls once more the contents of *On the Most Noble and Renowned Goldsmith's Art*. The text contains thirteen recipes for gilding silver, including three that specify partial gilding so that some silver is left visible, and three recipes for niello. All sixteen recipes are interwoven with alchemical discourses on their constituent materials, silver, gold, and sulfur. The presentation of artistic techniques as alchemical transformations comes into play in the *artophorion*'s function, both as a container for the host and as a reliquary. As a eucharistic vessel, the transformation that the *artophorion* underwent in its production mirrors the transubstantiation of bread to the body of Christ. As a reliquary, it mirrors the transformation of martyrdom, the potential for ordinary human remains to assume sacred power.

By incorporating artistic treatises into alchemical manuscripts and modifying them into alchemical documents, Byzantine authors and compilers consciously reframed art-making as a means of communicating ideas about matter and its transformation. No longer concerned only with the creation of substances but also with the creation of objects, Byzantine alchemical texts accorded new meaning to particular types of objects, their materials, and their processing. Metalwork and glass especially took on alchemical significance because of their inherently transformative natures. It is important to recognize that this phenomenon is specific to medieval Byzantine alchemy and medieval Byzantine art-making. It builds upon theoretical frameworks passed down from late antiquity, expanding, rather than simply recapitulating, ancient alchemical knowledge. It is in this innovative environment that, by the ninth century, a new medium

emerged to exploit fully the technical and conceptual potentials of Byzantine alchemy. That new material was enamel.

The "Sacred Art": The Fieschi-Morgan *Staurothēkē*

Byzantine authors deemed alchemy a θέιος τέχνη (*theios technē*, "sacred art"), an activity that was attuned to the divine workings of the cosmos as well as the physical workings of the material world.[52] I propose that, as part of this sacred activity, they turned toward making art in order to articulate notions about both the cosmos and matter. They emphasized the union of the cosmos and matter in esoteric representations like the *ouroboros*, yet, as demonstrated above, the artisanal turn in Byzantine alchemy also equipped objects to articulate such notions. As enameling emerged as an artistic technique in the ninth century, it became possible to use enamel in the expression of esoteric concepts as well. Alchemy itself is a mystery, in which materials undergo processing to reach a more refined, perfected state. This transformation can be read allegorically and mapped onto artistic processes, allowing a look at the Fieschi-Morgan σταυροθήκη (*staurothēkē,* "cross container") through the lens of alchemy (Fig. 19).

The Fieschi-Morgan *staurothēkē* (a reliquary for fragments of the True Cross), is the earliest dated enameled object made in Byzantium that employs the medium to depict figural representations, and to encase an object completely. Scholars have fiercely debated the

[52] As seen in titles of alchemical poems, Ἀρχελάου φιλοσόφου περὶ τῆς θείας τέχνης (*Archelaou philosophou peri tēs theias technēs*, "Archelaus the Philosopher on the Divine Art"), or Θεοφράστου φιλοσόφου περὶ τῆς αὐτῆς θείας τέχνης (*Theophrastou philosophou peri tēs autēs theias technēs*, "Theophrastus the Philosopher On the Same Divine Art"), both discussed in Günther Goldschmidt, *Heliodori carmina quattuor ad fidem codicis Casselani* (Giessen: A. Töppelmann, 1923), 34-42 and 50-59.

staurothēkē's date and location of production, but a consensus holds that the reliquary was made during the mid-ninth century in Constantinople.[53] Much art historical analysis of the *staurothēkē*

[53] The *staurothēkē* is conventionally dated either after the official end of Byzantine iconoclasm in 843 or slightly earlier, in the interlude between two periods of Iconoclasm from 787-814. A ninth-century date corresponds to the iconography of the Anastasis represented in niello on the interior of the lid and is supported by stylistic comparison with contemporary *cloisonné* produced in the Carolingian Empire. Once thought to be an indicator of "provincial" production in Syria or Palestine, the rudimentary style of the *staurothēkē*'s figural representation resembles Carolingian enamel to such a degree that it has led to speculation that the reliquary was made by Carolingian artisans for a Greek-speaking Orthodox community in Western Europe, or by itinerant Western goldsmiths working in Constantinople. A contrary, yet more likely, view proposes its manufacture by Byzantine goldsmiths working from Carolingian models that arrived in Byzantium through diplomacy or commerce. The inscriptions on the *staurothēkē* include misspellings, which have been attributed to an artisan who was unfamiliar with Greek. Misspellings are, however, a consistent feature of inscriptions in Byzantine art in general and should not be seen as necessarily indicating non-Byzantine production. A Byzantine origin for the *staurothēkē* is supported further by the layout of the reliquary's interior as a cross-shaped cavity with adjacent compartments (once closed with doors), a format exclusive to Byzantine reliquaries from the ninth century onward (I thank Brad Hostetler for sharing with me his forthcoming paper, presented at the Metropolitan Museum of Art's Fellows' Colloquium in 2017, which brings this point to light). Moreover, the reliquary was in Byzantine hands until the thirteenth century, when emperor John III Vatatzes (r. 1222 – 1254) gifted it to Pope Innocent IV (fl. 1243 – 1254), born Sinisbaldo Fieschi, during a series of diplomatic negotiations. Baron Albert Oppenheim subsequently purchased the *staurothēkē* from the Fieschi family and sold it to J.P. Morgan, hence its byname. See Marc Rosenberg, *Geschichte der Goldschmiedekunst auf technischer Grundlage: Zellenschmelz*, vol. 2 (Frankfurt: Verlag Heinrich Keller, 1921), 31-38; Klaus Wessel, *Byzantine Enamels from the 5th to the 13th Century* (Greenwich, CT: The New York Graphic Society, 1968), 43-44; Anatole Frolow, *Les reliquaries de la Vraie Croix* (Paris: Institut française d'etudes byzantines, 1963), 67-68; Anna D. Kartsonis, *Anastasis: The Making*

has focused on the lack of sophistication in its figural representation, which can fairly be described as rudimentary. Still, the object remains a masterpiece in terms of its facture. The transparent green background of the enamel endows the reliquary with a certain vitality as it reflects and refracts the light around it. The lush jewel tones and opaque surfaces of the figures stand out against the brilliant green, limned in gold and accompanied by glistening inscriptions. I posit that how the Fieschi-Morgan *staurothēkē* was made and what it was made from are aspects as meaningful as its imagery. Moreover, the making of the *staurothēkē* carried implications that nuanced its function as a reliquary. All three factors – representation, material, and function – work in concert, particularly when enamel is understood as an alchemical technology.

The reliquary's gilded silver exterior is clad with eighteen enameled plates on pure gold. On the lid, four trapezoidal plates representing saints Demetrios, Eustathios, Lawrence, Luke, Mark, Thomas, Jacob, Damian, Kosmas, Gregory Thaumaturgos, Bartholomew, Matthew, Jude Thaddeus, and Simon frame a central image of the Crucifixion (Fig. 20). On the Crucifixion plate, Christ hangs open-eyed from the cross beneath the sun and the moon, dressed in a deep

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of an Image (Princeton: Princeton University Press, 1986), 94-123; David Buckton, "Byzantine Enamel and the West," *Byzantinische Forschungen* 13 (1988): 235–54; David Buckton, "'Chinese Whispers': The Premature Birth of the Typical Byzantine Enamel," in *Byzantine East, Latin West: Art Historical Studies in Honor of Kurt Weitzmann*, ed. Doula Mouriki (Princeton: Princeton University Press, 1995), 591–96; Robin Cormack, "Reflections on Early Byzantine *Cloisonné* Enamels: Endangered or Extinct?" in *Θυμιαμα στη μνήμη της Λασκαρίνας Μπούρα* (Athens: Benaki Museum, 1994), 67-72; Anthony Cutler, "From Loot to Scholarship: Changing Modes in the Italian Response to Byzantine Artifacts, ca. 1200-1750," *Dumbarton Oaks Papers* 49 (1995): 237–67.

blue robe known as a *colobium* (a long robe).[54] To either side, the Virgin and John the Theologian make gestures of grief with their hands, though their eyes stare out at the viewer. The inscriptions surrounding Christ's head read, in severely mangled Greek, "Behold your son" and "Behold your mother" (John 19:26-27), indicating the moment that He spoke. On the sides of the reliquary are plates of enamel depicting saints Anastasios, Nicholas, Peter, Paul, John, Andrew, Panteleimon, Eustratios, Merkurios, Platon, Theodore, Prokopios, and Sergios (Fig. 21). Art historians and historians alike have tried to make sense of the arrangement of saints on the *staurothēkē*, but with no compelling conclusion.[55] Perhaps the fact that they are all saints was simply enough. On the interior of the lid, the shape of a cross divides the visual plane into four compartments bearing vignettes executed in niello of the Annunciation, the Nativity, a second instance of the Crucifixion, and the Anastasis (Fig. 22).

The Fieschi-Morgan *staurothēkē* presents itself as a tiny jeweled box, glimmering with holy figures and sacred scenes. In all the ways scholars have interpreted the reliquary, they have yet to point out that the central focus of its iconographic program is a series of mysteries that center upon material transformation. On the exterior, the Crucifixion foreshadows the impending Resurrection, the moment that Christ transformed bodily death to eternal life. All the figures on the borders of the *staurothēkē* share the mystery of martyrdom and redemption, the transformation of ordinary human beings into holy persons whose bodies and presence carried sacred power. On the interior, the Annunciation and the Nativity speak to the mystery of the

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[54] Once believed to indicate an earlier, sixth- or seventh-century date and Syrian origin, the *colobium* was in fact used in Byzantine iconography well into the ninth century. See Kartsonis, *Anastasis*, 108.

[55] For an early attempt to reconcile the choice of saints on the reliquary, see Rosenberg, *Zellenschmelz*, 122.

Incarnation, the transformation of divinity into flesh. The repetition of the Crucifixion amplifies the mystery of the Resurrection, dynamically represented in the vignette of the Anastasis. The *staurothēkē* confronts the viewer with compounded representations of materially transformative events that cannot be explained except through divine will, and its material and process of making compound the mysteries even further.

The Fieschi-Morgan *staurothēkē* is not only the earliest Byzantine work in enamel, but it is also composed of a combination of many materials subjected to alchemical processes. The core structure of the *staurothēkē* is gilded silver, recalling the focus on gilding procedures both in Pseudo-Democritus's *Physika kai Mystika* and the inclusion of gilding recipes in *On the Most Noble and Renowned Goldsmith's Art*. The niello on the interior of the reliquary's lid is the product of sulfur, lead, and silver fusion, creating a lustrous new substance appropriate for the representation of sacred transformations in which the divine fused with the human. The enamel too is a fusion, this time of glass and metal. Enamel, gilding, and niello all work together to elevate the mundane, albeit still precious, silver and gold, changing them into materials that surpass their original natural qualities.

The alchemical supranaturality of the materials and their processing parallels the *staurothēkē*'s iconography and complements the relic of the True Cross, itself a kind of supranatural material that testified to the ability of the body to resurrect and overcome death. In true keeping with the allegorical dimensions of alchemy, the material changes apparent in the *staurothēkē* could also serve as metaphors for theological concepts. In one of the earliest references to alchemy outside of the alchemical corpus, the fifth-century philosopher and Christian convert Aeneas of Gaza likened the resurrection of the body not just to alchemical gold-making, but also to glass. In his dialogue *Theophrastus*, the titular character discusses the

resurrection and questions the ability of the body to reunite with the soul and ascend to immortality. His interlocutor, Euxitheus provides a rebuttal:

> Change of matter to a better state is not implausible, for, among us too, experts in materials, taking silver and tin, making their form disappear, melting them down together and coloring them, and so changing the matter into something grander, have produced excellent gold. Again, sand is scattered and soda is abundant everywhere, but human skill has made glass out of them, new and transparent.[56]

In this passage, Aeneas of Gaza confronts doubts concerning the resurrection of the body by presenting the very artistic processes that produced the *staurothēkē* – gilding, enamel, and niello – as proof that matter can change to a state of perfection by means of human will. If human beings can transform matter, then God certainly can as well. Therefore, the decision to construct the *staurothēkē* from gilded silver, niello, and enamel may be more than a simple choice of precious materials. The materials and their processing also stand as proof of the mysteries represented in its imagery and the power of the relic it contained.

Conclusion

Two primary features characterize alchemy in medieval Byzantium: a deep engagement with the alchemical traditions of late antiquity, and an intensified incorporation of artisanal techniques into alchemical practice. The works of Pseudo-Democritus and Zosimos of Panopolis established a tradition in which artisanal techniques held epistemological and allegorical significance,

[56] Richard Sorabji, ed., *Aeneas of Gaza: Theophrastus, with Zacharias of Mytilene, Ammonius*, trans. John Dillon, Donald Russell, and Sebastian Gertz (London: Bristol Classical Press, 2012), 50.

allowing for artistic techniques and their products to be read allegorically. The logical conclusion of this marriage of technique, epistemology, and allegory was an "artisanal turn" in medieval Byzantine alchemy. Byzantine alchemical authors began including artistic treatises in their manuscript compilations as early as the tenth century, and these artistic treatises differ in format from the technical recipes popularized in late antique alchemy. Thus, it becomes possible to read certain types of extant Byzantine objects through an alchemical lens. Alchemical concepts augmented and strengthened concepts already communicated in iconography, particularly concepts of transformation and material perfection.

A relatively new medium in the ninth century, enamel emerged as a Byzantine art form within the environment of an artisanal turn in Byzantine alchemy. Byzantine artisans combined techniques already strongly associated with alchemy, such as gilding and niello, with the innovative process of enameling, creating objects like the Fieschi-Morgan *staurothēkē* that married alchemical ideas with notions of the salvation of humanity and the world through the supernatural behavior of matter. Through associations with alchemy, art-making took on new meaning. Enamel, an entirely man-made material that engineered the transformation and fusion of mundane substances, held special potential to convey those meanings.

Chapter Two

Byzantine Enamel as Aestheticized Technology

Enamel is dynamic. Under different environmental conditions it shifts in appearance, reflecting brilliantly from one angle, while darkening from another angle. When a *cloisonné* object is turned, the translucent glass catches light and its color intensifies dramatically. When turned another direction, the interlace of *cloisons* illuminates while the glass recedes into a silhouette, and the object is traversed by a web of golden lines. The viewer's eye becomes captivated by the medium as it constantly changes in hue and radiance, and the object's linear design slips in and out of focus. Enamel appears never to settle into a static state, rather it perpetually transforms. Similarly, making enamel is a dynamic process, as powdered glass first liquifies under heat, then solidifies as it cools, changing its physical state several times. Making enamel is also characterized by transformation, as glass and metal cease to be separate materials, fusing into a new, colorful and shining configuration. The captivating mutability of finished Byzantine enamel thus enacts its own making. The oscillating color and light render the completed object in a state of flux, changing and always coming into being.

Scholars have enthusiastically noted the mutability of Byzantine enamel as an aspect of its phenomenologically-perceived materiality.[1] Yet, in a crucial respect, enamel differs from other luxury media favored by the Byzantines, such as ivory or silver, which were acquired in a raw state and subsequently worked. By contrast, enamel is not a

[1] See especially Bissera Pentcheva, *The Sensual Icon: Space, Ritual, and the Senses in Byzantium* (University Park: The Pennsylvania State University Press, 2010), 97-120.

material from which an object is formed, rather enamel is made as the object itself is made. Enamel cannot be understood without examining enameling as a *process*.

Before looking at enameled objects, this chapter considers *enameling* – the act of making enamel – as it was perceived in the Byzantine scientific imagination. I propose that, in Byzantium, *processes of making* communicated meaning much as materials, form, or iconography. Recent studies of the meaning of making medieval art have approached making as a type of processual iconology that refers back to cultural values already in circulation.[2] I instead argue for the making of enamel as an *enactment* that both produces knowledge and satisfies a desire to demonstrate that knowledge. Key to my reformulation is an understanding of making as an active force for constructing meaning rather than a passive reflection of existing meanings.[3] Here Byzantine alchemy again

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[2] Ittai Weinryb has championed what he calls an "iconology of technique," in which how an object is made assumes symbolic value. These values, however, are already culturally extant prior to the fabrication of the object, for example, Weinryb relates medieval cast bronze objects to various scriptural and exegetical descriptions of man's creation. In Weinryb's iconology of technique, making might generate meaning, but that meaning is referential rather than innate. See Ittai Weinryb, *The Bronze Object in the Middle Ages* (Cambridge: Cambridge University Press, 2016), 45-53. Similarly, in her discussion of the *Schedula* of Theophilus Presbyter, Heidi Gearhart has framed making as an avenue toward the realization of monastic goals, such as a virtuous life or the exercise of free will, which she calls the "moralization" of artistic labor. Once again, it is extant principles, in this case Augustinian and Benedictine rules, that endow making with meaning. See Heidi C. Gearhart, *Theophilus and the Theory and Practice of Medieval Art* (College Park: The Pennsylvania State University Press, 2017), 67-88.

[3] In this respect, I build upon a theoretical framework for making set forth by anthropologist Tim Ingold, who argues for making as an active node of relational actors,

comes to the fore, through its insistence on artisanal making as the primary method for acquiring knowledge about the material world. Moreover, within Byzantine alchemical thought, all matter existed in a near-active state of potential, with the ability to change under the right combination of internal and external factors.[4] Making is the process by which that potential is unlocked and activated, and the behavior of matter can be observed. By designating enamels as "alchemical work," Byzantine authors implicitly assigned enameling a role within the alchemical tradition of making as an epistemological act.[5]

In this chapter I trace how enameling became perceived as an alchemical process. I chart how the alchemical nature of enameling manifested in enamel itself and elicited visual delight and wonder. I term this phenomenon "aestheticized technology," expanding on the idea of "alchemy as technology" laid out in the Introduction. I first inquire as to what "making" meant within Byzantine society, a question that the alchemical texts help to answer. The scholars and thinkers who studied alchemy in Byzantium were keenly aware of how artistic processes could confirm hypotheses about the physical world and generate new ones. As outlined in Chapter 1, the practice that

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consisting of materials, maker, and force. See Tim Ingold, *Making: Anthropology, Archaeology, Art and Architectur*e (London: Routledge, 2013), especially 44-45.

[4] On the Aristotelian concepts of potential and action and their absorption into the Greek alchemical corpus, see Cristina Viano, "Aristote et l'alchimie grecque: La transmutation et le modèle aristotélicien entre théorie et pratique," *Revue d'histoire des sciences* 49 (1996): 189–213.

[5] For discussion of Byzantine denotation of enamel as "alchemical work," see my Introduction.

went hand in hand with theory in Byzantine alchemy was frequently rooted in artisanal or craft traditions. Although studies of Byzantine alchemy have universally recognized alchemy's practical dimensions, they tend to focus on how closely alchemical practice might have reflected preexisting schools of thought rather than interrogating how the processes described in alchemical texts produced knowledge in original ways.

In contrast, historians of early modern science, such as Pamela H. Smith, have confronted this issue directly, asking to what extent making *was* knowing. Smith offers the term "artisanal epistemology" to explain the phenomenon of early modern German humanists' turning to artisanal techniques and craft traditions for evidence of the operations of nature and matter.[6] For these thinkers, artistic processes were necessary components of scientific discovery, akin and adjacent to experimentation. While Smith posits that artisanal epistemology marked the beginnings of the modern Scientific Revolution, her model has gained traction in studies of the Middle Ages, suggesting that a role for artistry in the search for knowledge has earlier origins.[7] I propose that some of those origins can be localized in Byzantium, where alchemical writers from Pseudo-Democritus (c. first century CE) to Michael Psellos (c. 1017 – 1078 CE) emphasized that making was key to the acquisition of knowledge.

I next examine enameling itself and look closely at different steps of the enameling process. Regardless of the specific enameling technique, whether *cloisonné*,

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[6] Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004), 59–93.

[7] For example, see Ittai Weinryb, "Material and Making: Artisanal Epistemology at St. Gall," in *Tuotilo. Archäologie eines frühmittelalterlichen Künstlers*, ed. David Ganz and Cornel Dora (St. Gallen: Verlag am Klosterhof, 2017), 269–84.

champlevé, full, or sunk, enameling processes always involve moments of transformation that actively demonstrate the behavior of matter.[8] For Byzantine observers, enameling had the capacity to reveal the mechanisms behind material change. Enamel alters its physical state over the course of manufacture, with fire and heat as the agents of change. This process corresponded to Byzantine theories of transmutation as a shift in balance among the four elements. Enamel changed color, which was understood as a crucial indicator of substantial transmutation in Byzantine alchemical thought. Ultimately, enameling generated a new substance composed of two disparate materials. It must be noted, however, that instead of simply signifying previously held notions about the behavior of matter, enameling was alchemy in action. As the enameling process unfolded, it achieved alchemical goals and testified to the ability of its makers to control matter and transform it at will.

I next draw upon contemporary theories of making to argue that the alchemical knowledge that enameling enacted was critical to its aesthetic appreciation. Making is a generative process that not only produces knowledge and objects, but also elicits human participation and response. Viewers and users take pleasure in exquisitely made things by identifying steps in the making process and recognizing their own possession of the specialized knowledge that went into an object's creation. As indicated in the very terms for enamel, χυμευτός/χειμευτός (*chymeutos*/*cheimeutos*, "melted thing" or "alchemical thing") and ἔργα χυμευτά/χειμευτά (*erga chymeuta*/*cheimeuta*, "melted work" or "alchemical work"), the Byzantines defined the medium by its process of transformation through melting, indicating that how enamel was made was essential to how elite

[8] For definitions of these enameling techniques, see my Introduction.

Byzantine patrons and viewers conceptualized the medium. Therefore, I propose, finished enameled objects materialized knowledge itself, turning knowledge into a visually manifest quality to be enjoyed.

Enamel's "made-ness" also freed it from the constraints posed by other luxury materials, such as gold, silver, ivory, or textiles, which had to be sourced from territory under Byzantine control or acquired through trade. Through making, artisans shifted the source of Byzantine power from occupied land to knowledge itself. As I discuss in detail, knowledge, power, and beauty coalesce in a series of medieval accounts of a marvelous enameled altar table purportedly made for the great church of Hagia Sophia in Constantinople, which authors such as George Kedrenos (fl. twelfth century CE) and Niketas Choniates (c. 1155 – 1217 CE) described as an alchemically-made technological wonder. These accounts are first attested in the ninth century, the same period that enamel emerged as a Byzantine art form.

At the close of this chapter, I analyze a tenth-century pectoral cross once housed in the Georgian monastery of Martvili. This cross employs enamel not only figurally, but also as rings of pure color encircling gemstones at each of the four terminals. I suggest that on the Martvili Cross, the enamel rings make a crucial pronouncement about the man-made nature of this object and the knowledge it embodies. The rings resemble neither of the medium's constituent materials – glass and metal. Instead the rings manifest a new, composite material – a fused body – that announces enamel's extraordinary "made-ness" together with the rarefied knowledge that Byzantine artisans used to bring it into being.

Making-as-Knowing in Byzantine Alchemy

In modern studies, the aspect of Byzantine alchemy that scholars note most frequently is its distinctly practical character, that is, the implementation of technical and artisanal πρᾶξις (*praxis*, "practice") to discover and express ideas about the operations of physical matter. Matteo Martelli has called Byzantine alchemy a "continuous interplay between practice and theory," while Gerasimos Merianos contends that Byzantine alchemy "attempts to apply philosophical principles in practice; it is therefore a field combining philosophy with laboratory operations, the 'know why' with the 'know how.'"[9] In the introduction to a recently published volume on Greek alchemy, the editors Vangelis Koutalis, Martelli, and Merianos further stress the importance of practice within Byzantine alchemy, noting that alchemical writers, "did not possess a common theoretical language and they seem to rely on the operational experience accumulated through artisanal practice more consistently than they did with respect to the conceptual edifices bequeathed by classical Greek philosophy."[10] That is to say, while in the past

[9] Matteo Martelli, "Greco-Egyptian and Byzantine Alchemy," in *A Companion to Science, Technology, and Medicine in Ancient Greece and Rome*, ed. Georgia L. Irby (Hoboken: Wiley-Blackwell, 2016), 229; Gerasimos Merianos, "Alchemy," in *The Cambridge Intellectual History of Byzantium*, ed. Anthony Kaldellis and Niketas Siniossoglou (Cambridge: Cambridge University Press, 2017), 243.

[10] Koutalis, Martelli, and Merianos reiterate the position of Olivier Dufault, who demonstrates that there is no single theory of transmutation in the Greek alchemical corpus, and that the only consistent feature of Greek alchemy comes from its engagement with artisanal practice. See Vangelis Koutalis, Matteo Martelli, and Gerasimos Merianos, "Graeco-Egyptian, Byzantine and Post-Byzantine Alchemy: Introductory Remarks," in *Greek Alchemy from Late Antiquity to Early Modernity*, ed. Efthymios Nicolaïdis

scholars have looked to the technical, practical aspects of alchemy to reveal underlying philosophical frameworks drawn from classical Greek thought, those frameworks are varied rather than systematized or streamlined. What is systematized, however, is the role of practice to express the multiple philosophical and theoretical positions that alchemy could take.[11] The most consistent feature of Byzantine alchemy, then, is its focus on *making* as a route to the acquisition and demonstration of knowledge.

Making in Byzantium, and in the alchemical corpus, was expressed through the term ποίησις (*poiēsis*, "creation, fabrication, or procedure"). *Poiēsis* appears frequently in the titles of alchemical texts, for example as Χρυσοῦ ποίησις (*chrysou poiēsis*, chrysopoeia, or "making of gold"), Ποίησις ἀργύρου (*poiēsis argyrou*, "making of silver") or even simply Ἡ ποίησις (*Hē poiēsis*, "the making") as a term for alchemy itself.[12] There is near-universal agreement among modern scholars – and internally within the alchemical corpus – that processes drawn from art-making were crucial to discovering and articulating alchemical principles. Surprisingly, however, scholarship on Byzantine intellectual culture has yet to take seriously the role of making as a form of knowing in its own right. Instead, modern scholars typically see alchemical making as a form of allegory, in which artistic processes are used as comparisons for the operations of primordial matter.[13] At best, making is seen as an attempt to put pre-existing knowledge

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(Turnhout: Brepols, 2018), 23; Olivier Dufault, "Transmutation Theory in the Greek Alchemical Corpus," *Ambix* 62, no. 3 (2015): 215–44.

[11] Dufault, "Transmutation Theory," 215-44.

[12] For just a few examples of treatises titled "making gold," see *CAAG* III:25-26, 382-83; for "making silver" see *CAAG* III:36-37, 389-90; for "the making" see *CAAG* III:284.

[13] Dufault, "Transmutation Theory," 217.

of matter into active practice. This position privileges the textual tradition of alchemy, and philosophical theory more generally, over the practical tradition and the more "vernacular" knowledge generated through artisanal labor.[14]

I posit that, in medieval Byzantium, making can – indeed must – be understood as a form of knowing in its own right. In an argument that has major repercussions for our understanding of Byzantine natural philosophy, Gianna Katsiampoura has recently observed that if alchemy is a class of knowledge drawn from ordinary artisanal practice, it is entirely possible that much of Byzantine knowledge of natural philosophy was not imposed upon artistic processes at some later date, but rather intentionally constructed from interactions between educated Byzantine thinkers and skilled artisans.[15] Given that artisans worked directly with various materials, any communication between scholars and artisans was an opportunity to exchange knowledge, particularly concerning the behavior of physical matter.

As Katsiampoura notes, this idea echoes a well-known theory from the history of science: the Zilsel Thesis. Named for its originator, Edgar Zilsel (1891 – 1944), the Zilsel Thesis posits that the modern scientific method arose in the sixteenth and seventeenth centuries due to the blurring of boundaries between scholars, humanists, and artisans

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[14] On "vernacular" knowledge, see Pamela H. Smith, "Making as Knowing: Craft as Natural Philosophy," in *Ways of Making and Knowing: The Material Culture of Empirical Knowledge*, ed. Pamela H. Smith, Amy R.W. Meyers, and Harold J. Cook (Ann Arbor: University of Michigan Press, 2014), 14–47.

[15] Gianna Katsiampoura, "The Relationship between Alchemy and Natural Philosophy in Byzantine Times," in *Greek Alchemy from Late Antiquity to Early Modernity*, ed. Efthymios Nicolaïdis (Turnhout: Brepols, 2018), 129.

during the rise of early modern mercantile capitalism.[16] Historian of early modern science Pamela O. Long has again taken up the Zilsel Thesis and characterized certain arenas in the early modern world, such as armories and shipyards, as epistemological "trading zones," where craftsmen and intellectuals exchanged their respective expertise.[17] Both the Zilsel Thesis and Long's concept of "trading zones" have been applied only to the early modern period and have been positioned in direct opposition to the perceived social stratification between scholars and craftspeople in the Middle Ages. Yet in Byzantium, at least, the alchemical corpus indicates that artistic practice was crucial to understanding the world. The new conception of enamel-making in Byzantium proposed here also has broader implications for how we should draw, and blur, the lines between the "medieval" and "early modern" thought worlds.

One model for considering making as a form of knowing in Byzantium comes again from studies of making in the early modern period, which likewise have an alchemical context. In her study of the Swiss-born alchemist and polymath Paracelsus (1493 – 1541), Pamela H. Smith articulates what she calls "artisanal epistemology": a system by which Paracelsus understood making art to be a crucial means of creating knowledge.[18] In this model, knowledge is obtained first through practical experience and

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[16] Edgar Zilsel, "The Sociological Roots of Science," *The American Journal of Sociology* 47 (1942): 544-62; reprinted in *Social Studies of Science* 30, no. 6 (2000): 935–49.
[17] Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600* (Corvallis, OR: Oregon State University Press, 2011), 10-29, 94-126; Pamela O. Long, "Trading Zones in Early Modern Europe," *Isis* 106, no. 4 (December 2, 2015): 840–47.
[18] Smith, *The Body of the Artisan*, 59-60.

engagement with nature and matter, and second through systematized theorization.[19] Smith asserts that Paracelsus' artisanal epistemology was "an extraordinary inversion of the concepts of theory and practice…in the organization of knowledge that held from antiquity up through the seventeenth century," and thus a phenomenon exclusive to early modernity.[20]

Yet much of Byzantine alchemical writing anticipates the artisanal epistemology of Paracelsus and other German artists and humanists that Smith studies. For example, Smith argues that Paracelsus, Martin Schöngauer (c. 1450 – 1491), and Albrecht Dürer (1471 – 1528) "believed they possessed a species of knowledge, based on nature and extracted through bodily work." [21] Their position can be contrasted with a passage from the *Physika kai Mystika* of Pseudo-Democritus, one of the most highly-praised and copied alchemical texts in the Byzantine world.[22] In one passage, Pseudo-Democritus criticizes certain practitioners of alchemy who refuse to investigate matter through practical experience. He couches his criticism in a long description of processes drawn from metalworking and stakes a claim to certain types of knowledge that can only be acquired through making. He writes:

> In fact, they believe that we are presenting a legendary rather than a secret discourse, so they do not carry out any close examination of the species [i.e., discrete substances]: for example, where one species can cleanse, another can be applied; where one species can dye, another can combine; and whether one species can make things bright and, with respect to this

[19] Smith, *The Body of the Artisan*, 86-88.

[20] Smith, *The Body of the Artisan*, 88.

[21] Smith, *The Body of the Artisan*, 93.

[22] Regarding this text, see Chapter 1.

> brightness whether it is vanishing and vanishes from the inside, and whether one species can resist fire, and another, when mixed, can make things fire resisting; for instance whether salt cleanses the surface of copper and whether it properly cleanses its inner part [i.e., its essence]; and, after this cleansing process, whether it rusts the surface and whether it rusts the inner part, and whether mercury cleanses and whitens the surface of a gold-copper alloy, and whether it makes its inner part white; and whether it [i.e. the whitening produced by mercury] vanishes from the surface and whether it will vanish from the inside. If these novices had practiced these kinds of investigations, they would not be in trouble, since they could set to work with good judgment.[23]

In this passage, which is somewhat difficult to follow, Pseudo-Democritus criticizes practitioners of alchemy who approach it as the supernatural work of *daimons,* or spirits. He contrasts this group with those who practice alchemy through hands-on experimentation with artisanal techniques. His discussion of "species" – that is, "discrete substances" – employs the vocabulary of metallurgy and describes processes ranging from pickling metals in salt in order to cleanse them to mercury amalgamation, a

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[23] Δοκοῦντες γὰρ ἡμᾶς μυθικὸν, ἀλλ' οὐ μυστικὸν ἀπαγγέλλειν λόγον, οὐδεμίαν ἐξέτασιν ποιοῦνται τῶν εἰδῶν· οἷον εἰ τόδε μέν ἐστι σμηκτικὸν, τόδε ἐπιβλητέον, καὶ εἰ τόδε μέν ἐστιν βαπτικὸν, τόδε ἁρμοστέον, καὶ τόδε εἰ τὴν ἐπιφάνειαν ποιεῖ, καὶ εἰ κατὰ τὴν ἐπιφάνειαν ἔσται φευκτὸν, καὶ ἐκ τοῦ βάθους φεύξεται, καὶ εἰ τόδε μέν ἐστι πυρίμαχον, τόδε προσπλακὲν πυρίμαχον ποιεῖ, οἷον εἰ τὸ ἅλας σμήχει τὸ ἐπάνω τοῦ χαλκοῦ καὶ τὰ ἐντὸς ἐξ ἅπαντος σμήχει, καὶ εἰ ἰοῖ τὰ ἔξω μετὰ τὴν σμῆξιν, καὶ τὰ ἐντὸς ἰοῖ· καὶ εἰ τὰ ἔξω τοῦ χρυσοχάλκου λευκαίνει καὶ σμήχει ἡ ὑδράργυρος, καὶ τὰ ἐντὸς λευκαίνει· καὶ εἰ φεύγει ἔξωθεν, καὶ ἐκ τῶν ἐντὸς φεύξεται. Εἰ ἐν τούτοις ὑπῆρχον ἀσκούμενοι οἱ νέοι, οὐκ ἂν ἐδυστύχουν, κρίσει ἐπὶ τὰς πράξεις ὁρμῶντες· Matteo Martelli, ed. and trans., *The Four Books of Pseudo-Democritus* (Leeds: Maney Publishing, 2013), 96-97.

longstanding method for gilding silver. He particularly emphasizes how investigations will demonstrate whether these processes produce only superficial effects or whether they affect a material in its essence, on its "inner part." For Pseudo-Democritus, engaging with matter in the manner of artisanal making is a type of investigation that ultimately leads to knowledge, or "good judgment."

Pseudo-Democritus is hardly the only alchemical author to equate making with knowing. Zosimos of Panopolis (fl. 300 CE), the most copied and perhaps most esteemed author in the Byzantine alchemical tradition, assessed processes according to their proper "natural times," in accordance with the seasons and positions of planets, thus linking making to the proper knowledge of the cosmos.[24] He instructs the reader in the making of a whitening agent, a substance that will change colored metals into silver, as follows:

> Take the alabaster stone, fire it for one day and one night; you get lime. Take very strong vinegar and quench it. And you will be amazed; for it is a divine creation that makes [surfaces] white. Let stand and add very strong vinegar, not in a closed container but an uncovered one, to let the vapor rise each time. Taking more strong vinegar, [add it and] allow the vapor to rise for seven days. Do this [i.e., add vinegar] until the vapor no longer rises, then leave it for forty days in the sun and the dew that appears during this time. Soften it with rainwater and, after drying in the sun, you hold the incommunicable mystery…[25]

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[24] Shannon Grimes, "Natural Methods: Examining the Biases of Ancient Alchemists and Those Who Study Them," in *Esotericism, Religion, and Nature*, ed. Arthur Versluis et al. (Minneapolis: North American Academic Press, 2010), 5–26.

[25] Λαβὼν οὖν τὸν ἀλαβάστρινον λίθον, ὄπτα νυχθήμερον, καὶ ἔχε ἄσβεστον, καὶ λάβε ὄξος δριμύτατον καὶ κατάσβεσον· καὶ θαυμάσεις· θείαν γὰρ ποίησιν τὴν ἐπιφάνειαν λευκοτάτην ποιεῖ. Καὶ ἔα καταστῆναι, καὶ ἐπίβαλλε αὐτῷ ὄξους δριμυτάτου οὐκ ἐμφίμῳ

In this passage, Zosimos' recipe for the whitening agent is a simple concoction of lime and vinegar that culminates in the ultimate revelation of the mystery of transmutation. Notable, however, is how the procedure relies on natural processes. As Shannon Grimes notes, his direction to leave it in the sun and rain in order to mature echoes the rhythm of plant growth and is in keeping with Zosimos' insistence on procedures working in harmony with nature.[26] Here making is an imitation of natural sequences and thus a demonstration of knowledge about the functions of natural processes. The alchemist, upon successful completion of the work also reveals a mystery, that is, the inner workings of matter, and becomes an initiate into a higher level of knowing.

Perhaps the most compelling character for an examination of making-as-knowing in Byzantium is the semi-legendary figure known only as Maria "The Jewess" (Ἰουδαικάς) or the "Divine" (θεία) Maria (fl. c. first to third century CE).[27] Maria does not appear as an author of any single treatise in her own right, but her teachings and

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ἀλλ'ἀπώμῳ, ἵνα τὴν ἐπιτρέχουσαν αἰθάλην καθ' ἑκάστην ἐπαίρῃς· ἔτι λαβὼν ὄξος δριμὺ δι' ἑπτὰ ἡμερῶν τὴν αἰθάλην ἐπαίρῃς, οὕτως ποίει ἄχρις ἂν ἡ αἰθάλη μὴ ἀναπέμπηται. Καὶ ἔασον ἡμέρας τεσσαράκοντα ἐν ἡλίῳ καὶ δρόσῳ τῇ ἐμπροθέσμῳ, γλύκανον ὕδατι ὑετίῳ. Καὶ ξηράνας ἐν ἡλί ἔχε τὸ μυστήριον ἀμετάδοτον… Michèle Mertens, ed. and trans. *Les alchimistes grecs. Zosime de Panapolis. Mémoires authentiques* (Paris: Les belles lettres, 1995), 47-49.

[26] Grimes, "Natural Methods," 9-11.

[27] The most comprehensive overview of Maria as a figure within the Greek alchemical corpus, as well as within Islamic alchemy and early modern European alchemy, remains Raphael Patai, "Maria the Jewess - Founding Mother of Alchemy," *Ambix* 29, no. 3 (1982): 177–97.

inventions are found in summaries and paraphrased passages throughout the alchemical corpus. Most notably, citations of Maria's teachings appear in the works of Zosimos and Olympiodoros (fl. sixth century CE). The textual record presents Maria foremost as a technician, even an engineer, as well as a sophisticated alchemical theorist. In Zosimos' writings Maria is the inventor of numerous furnaces and apparatuses intended for distillation and cooking, depictions of which are scattered throughout the manuscripts of the alchemical corpus with careful attention paid to labeling individual parts and their functions (for example, Fig. 23). When Zosimos paraphrases Maria, a kind of artisanal expertise emerges on her part, particularly a deep familiarity with materials and how they are processed. Maria recommends, for example, the use of glass instruments because they allow the practitioner to observe processes unhindered.[28] Zosimos repeats several times Maria's cautions against the harmful vapors of mercury, which Maria notes is poisonous because it dissolves gold.[29] Olympiodoros cites Maria in his commentary on Zosimos, a text that includes excerpts from the most notable of Greek alchemical authors in order to construct a doxography (a collection of viewpoints).[30] Unlike Zosimos, Olympiodoros makes no mention of Maria's ingenious devices and instead quotes her teachings on heat-treating minerals, the principles of unifying various metals into single alloys, and in one

[28] Patai, "Maria the Jewess," 178-79.

[29] Patai, "Maria the Jewess," 179.

[30] On this text and its structure see Cristina Viano, "Byzantine Alchemy, or the Era of Systematization," in *Oxford Handbook of Science and Medicine in the Classical World*, ed. Paul T. Keyser and John Scarborough (Oxford: Oxford University Press, 2018), 943–64.

case cites Maria's elucidating the difference between natural lead and fabricated lead.[31] These are all technical processes that Maria has undertaken to provide an explanation in the tradition of natural philosophers. Indeed, Olympiodoros includes her as an authority among such ancient sages as Plato, Aristotle, and Parmenides. For Zosimos and Olympiodoros, then, Maria is a philosopher and an artisan *par excellence*. The model of a perfect alchemist, Maria's skills in making are both informed by and generate knowledge.[32]

Last but not least, Michael Psellos begins his letter to the Patriarch of Constantinople, Michael I Keroularios (fl. 1043 – 1059) by reiterating the link between making and knowing. He exhorts the patriarch as follows:

> You see, my lord, my soul's sovereignty, what you're doing to me by lowering me from philosophy's greatness to the lowly fire-craft [τὴν ἐμπύριον τέχνην, i.e., alchemy] and ordering [me] to transform matter and transmute natures, even if this [practice] has elevated a philosopher to the knowledge of Nature.[33]

Here Psellos' protest at being asked to address alchemy is merely a rhetorical device, given that he immediately acknowledges that crafts involving fire have revealed nature's

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[31] *CAAG* I:71, 93.

[32] There is one other instance in which Maria is quoted. In an anonymous alchemical text on the fabrication of gemstones, many recipes are attributed to her composition. See Appendix II.B, section 9 and Chapter Three.

[33] Ὁρᾷς, ὁ ἐμὸς δυνάστης, ὅ με ποιεῖς, ἡ τῆς ἐμῆς ψυχῆς τυρρανίς, ἀπὸ τοῦ τῆς φιλοσοφίας μεγέθους ἐπὶ τὴν ἐμπύριον καταβιβάζων τέχνην καὶ βάναυσον, καὶ πείθων τᾶς ὕλας μετακινεῖν καὶ τὰς φύσεις μεταποιεῖν, εἰ καὶ τοῦτο ἴσως φιλόσοφον καὶ τῆς περὶ τὴν φύσιν ἐπιστήμης ἠώρηται. For full translation and commentary, see Appendix I.

secrets. Like Zosimos, Psellos, too, locates knowledge within natural phenomena through an anecdote taken from his youth. He describes an encounter with petrified wood as follows:

> Not long ago I saw a root (I was little more than a young man, and I had only been initiated into the introductory rites of philosophy) I believe, of a tree, perfectly transformed into stone. It was a wondrous sight, something halfway between both natures. It was marked, in fact, by fibrous growths, according to the essence of trees, and covered all around with a hard shell, partly wrinkled, partly having navel-like pores, however, it was entirely hard, pure stone. Back then I was simply amazed and left it alone: but after progressing farther in philosophy, I was convinced that the oak had been struck by lightning, not by the kind which burns and blackens, but by the most rarefied and swiftest. This lightning instantly penetrated the pores of the tree and consumed all the sap, and expended the aerial essence in the pores, and narrowed the space between the fibers, and changed the spongy wood into rigid stone.… Since I have sufficiently shown in the introduction that the changes in materials come from a natural alteration and not from some enchantment or prodigy or some other secret manipulation (wonder, therefore, is not the right response).[34]

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[34] Ἐγω γοῦν αὐτος ἐθεσάμην οὐ πάνυ πρὸ πολλῦ χρόνου (ἔφηβος γὰρ τότε ἦν ἢ καὶ τὰ προτέλεια τῆς φιλοσοφίας μυούμενος) ῥίζαν, ὡς οἰμαι, δρυὸς ἀκριβῶς εἰς λίθον μεταβληθεῖσαν, καὶ ἦν θαυμάσιον τὸ ὁρώμενον· μεταίχμιον γὰρ ἀμφοτέρων τῶν φύσεων ἦν· διείληπτο μὲν γὰρ ἰνώδεσιν ἀποφύσεσι κατὰ τὴν τῶν δένδρων οὐσίαν, στεγανῷ τε κελύφει κατακεκάλυπτο, τὰ μὲν ῥυσσούμενον, τὰ δὲ καὶ εἰς ὀμφαλίτιδας πόρους δεικνύμενον· τὸ δ᾽ὅλον ἀντιτυπὲς ἦν καὶ λίθος καθαρῶς. Τότε μὲν οὖν ἁπλῶς θαυμάσας ἀφῆκα· ὕστερον δὲ γενναιότερον τῇ φιλοσοφιᾳ προσβάς, κεραυνῷ βεβλῆσθαι ἡγησάμην τὴν δρῦν, οὐ τῷ καυσώδει τούτῳ δὴ καὶ μελαίνοντι, ἀλλὰ τῷ λεπτοτέρῳ καὶ ταχυτέρῳ, ὃς δὴ ἀθρόον τοῖς τῆς δρυὸς προσελάσας πόροις καὶ τὴν ἰκμάδα πᾶσαν ἐξαναλώσας, την τε ἐν τοῖς πόροις ἀερώδη οὐσίαν ἐκδαπανήσας, το τε διεστηκὸς συνέσφιγξε τῶν ἰνῶν καὶ εἰς

While Psellos' recollection of the piece of petrified wood serves to bolster his repeated assertions that alchemy is not magic, it also illuminates his beliefs about the specific mechanics of transmutation. Transmutation is a natural behavior of matter, which he knows through experience with the physical world, and which he ultimately demonstrates through processes of making that replicate natural conditions. Indeed, following the story of the petrified root, Psellos recounts several straightforwardly technical recipes intended to exhibit the knowledge he has acquired.[35] Also worth noting is Psellos' emphasis on wonder and amazement, which he equates both with not knowing how the root was made and with the patriarch's lack of knowledge as to how transmutation operates. Those who experience amazement are uninitiated into alchemy's secrets, whereas those who know the inner workings of alchemy take satisfaction instead in their knowledge of natural processes.

These passages taken from Byzantine alchemical texts show that Byzantine theorists understood knowledge to be located in nature and revealed through observation and making. In other words, Pamela Smith's theory of artisanal epistemology applies as much to some schools of early and middle Byzantine thinking as it does to Western early modern thinking. Making was a crucial method of knowledge acquisition in Byzantium, particularly through alchemical procedures that borrowed from artistic practice. Making

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λίθου στερρότητα τὴν τῆς ὕλης μανότητα μετεποίησεν…Ἐπεὶ οὖν ἱκανῶς ἡμῖν πεπροοιμίασται ὡς αἱ τῶν ὑλῶν μεταβολαὶ φυσικήν τινα ἀλλοίωσιν ἔχουσιν καὶ οὐκ ἐξ ἐπῳδῆς τινος ἢ τερατείας ἢ ἄλλης ἀρρητουργίας (διὸ καὶ θαυμάζειν οὐ χρή)… For a full translation and commentary, see Appendix I.

[35] See Appendix I, sections 7-8.

exposed the behaviors and operations of matter and could articulate differing theories about matter across Byzantine alchemical theory and natural philosophy. Moreover, the alchemical texts present a *topos* particular to making and to process – that of the secrecy, revelation, and amazement provoked by knowing or *not* knowing. The focus on process thus reveals a two-pronged power dynamic in Byzantine thought, in which some observers of made things did not understand how they were made, and thus marveled, and others did understand the process of making, and took pleasure in understanding things that others did not comprehend. Whether through knowing or not knowing, the made-thing elicits a noteworthy reaction, an experience of pleasure, or perhaps admiration. To change from one mode of viewing to another, to go from not knowing to knowing, one must participate in or, at least, observe making. For these Byzantine alchemical authors, making was the full realization of knowledge.

Alchemy in Action: Enameling as "Alchemical Work"

When Byzantine authors deemed enamels "alchemical things" and "alchemical work," they both defined enamel by how it was made and situated its making within the alchemical tradition in which making was a form of knowledge production.[36] Even on the surface, this designation is common sense. To make enamel, a mixture of very ordinary materials – glass, metal, mineral oxides – is subjected to fire and fused into a new, magnificently-colored composite more radiant and splendid than its constituent parts. Enameling is a process of transmutation, in which the final product is irreversibly changed from its prior state, a total and complete material transformation. When broken

[36] On the designations "alchemical things" and "alchemical work," see my Introduction.

down into stages, enameling is also progressively transformative, with smaller material changes taking place at different points in its making before culminating in fusion. Mixture, fusion, and transformation all lend themselves to an alchemical reading of enamel, but the alchemical principles that enameling enacted have yet to be fully unpacked. A careful consideration of specific stages of the enameling process, most of which are ephemeral and fleeting, is one way to illuminate the relationship between enameling and alchemy.

In the past, scholars have turned to textual evidence to shed light on techniques of enameling. In his *Schedula*, the eleventh-century Benedictine monk, Theophilus Presbyter discusses at length and in straightforward terms the steps of enamel manufacture and details the materials and equipment used in enameling. From the earliest studies of enamel in the nineteenth century to the present day, Theophilus' account has been privileged as the primary source for information on medieval enameling in general, whether Byzantine or Western.[37] Although both Theophilus and Byzantine authors focus

[37] See, for example, Johannes Schulz, Aleksandr Viktorovich Zvenigorodskiĭ, and Andreas Curtius, *Der byzantinische zellenschmelz* (Frankfurt: Druckerei von A. Osterrieth, 1890), 32-41; Marc Rosenberg, *Geschichte der Goldschmiedekunst auf technischer Grundlage: Zellenschmelz*, vol. 2 (Frankfurt: Verlag Heinrich Keller, 1921), 50-59; Klaus Wessel, *Byzantine Enamels from the 5th to the 13th Century* (Greenwich, CT: The New York Graphic Society, 1968), 13-14; Günther Haseloff, *Email im Frühen Mittelalter: Frühchristliche Kunst con der Spätantike bis zu den Karolingern* (Marburg: Dr. Wolfram Hitzeroth Verlag, 1990), 15-23; David Buckton, "Theophilus and Enamel," in *Studies in Medieval Art and Architecture: Presented to Peter Lasko*, ed. David Buckton and T.A. Heslop (London: Trustees of the British Museum, 1994), 1–13; Paul Hetherington, "Byzantine *Cloisonné* Enamel: Production, Survival and Loss," *Byzantion*

on the meaning of making, there is a stark difference in the intentions behind the composition of the *Schedula* and the Byzantine texts in which enameling appears. Heidi Gearhart has recently interpreted the *Schedula* as an example of systemized theorization of art-making in the Middle Ages, but within the context of what she has called "the spirituality of labor and manual work" consistent with its production in a Benedictine monastery.[38] By contrast, the Byzantine writings on enameling (to be discussed at length in Chapter Three) appear solely in alchemical compilations and compendia, thereby making a firm statement regarding their intellectual classification. Moreover, the Byzantine texts lack a self-consciously spiritual dimension and instead seek to articulate the operations of matter as part of a larger endeavor aimed toward the ordering and controlling of nature. Theophilus' directives for enameling are thus appropriate for the study of making as a theologically-charged endeavor in the medieval West, but should not be applied unreservedly to Byzantine attitudes towards making enamel.

Rather than relying on the *Schedula* of Theophilus, I privilege evidence from the Greek alchemical corpus considered in concert with the actual processes of enameling. I do not, however, investigate each step of the enameling process. Instead I focus on transformative actions, by which I mean moments in the process that enact material change. By foregrounding the active nature of enameling to illuminate the stages of

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76 (2006): 185-220 at 187 n6; Antje Bosselmann-Ruickbie, "Das Verhältnis der *Schedula diversarum artium* des Theophilus Presbyter zu byzantinischen Goldschmiedearbeiten: Grenzüberschreitende Wissensverbreitung im Mittelalter?" in *Zwischen Kunsthandwerk und Kunst: Die "Schedula diversarum artium,"* ed. Andreas Speer, Maxime Mauriège, and Hiltrud Westermann-Angerhausen (Cologne: de Gruyter, 2013), 333–68.

[38] Gearhart, *Theophilus and the Theory and Practice of Medieval Art*, 2–12.

transformation that arise in the process, I follow the lead of Pamela Smith. In addition, I employ the methods of experimental archaeologists, who use reconstruction and reenactment to shed light on aspects of process that are experiential and perceived most effectively through firsthand participation. Specifically, I draw from my own experience making enamel with a cohort of contemporary master goldsmiths and enamellers.[39] As part of her research and on a larger scale through her "Making and Knowing Project" (founded in 2014 at Columbia University), Smith has long advocated for historians to embrace reconstruction precisely because experience often fills gaps left in historical writing about practice.[40] Smith is quick to note that the knowledge obtained through

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[39] My reconstructive *cloisonné* enameling work has taken place from 2017 to the present at the JewelryClassDC studios in Washington, D.C., with master goldsmiths Daniel Valencia and Emily Marquis, goldsmith Laura Ziang, and contemporary enameller Vera Meyer. At JewelryClassDC our processes differ in key respects from those attested in Byzantine treatises that discuss enameling, and so my reconstruction does not attempt to replicate Byzantine enameling conditions exactly. We enamel on fine silver rather than gold, both due to cost constraints and because contemporary glass formulas for enameling are not ideally suited for work on gold. We also use a contemporary enameling kiln rather than the open fire and coals used in medieval Byzantium. These decisions are informed by the limits of budget, materials, time, and facilities. Our reconstruction is focused, however, on process, on experiencing the challenges that arise during fabrication and the physical cues that indicate the successful (or unsuccessful) completion of an enameled work, which offers important insight into the processes described in Byzantine alchemical texts as well as crucial perspective to assist in "reading between the lines" of these often terse technical accounts.

[40] Pamela H. Smith, "In the Workshop of History: Making, Writing, and Meaning," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture*, 19, no. 1 (2012): 4–31. For discussion of reenactment and recreation as methodology in history

reconstructive making has its limits, but it nonetheless provides evidence that brings scholars closer to comprehending the thinking and learning strategies of the cultures they study, which often privileged experiential and practical approaches. As Smith asserts, making is knowing for the historian as well as for the subject of historical inquiry.

Within the sphere of Byzantine studies, reconstruction is comparatively rare, but has been essential to answering questions about another technology associated with alchemy, the weapon known as "Greek fire."[41] Greek fire was called variously πῦρ θαλάσσιον (*pyr thalassion*, "sea fire"), πῦρ κολλητικόν (*pyr kollētikon*, "sticky fire"), and πῦρ σκευαστόν (*pyr skeuaston*, "manufactured fire"). The weapon was an incendiary substance projected by a siphon and employed primarily, although not exclusively, in naval battles. Its composition was one of Byzantium's most preciously guarded state secrets. Among the known ingredients of Greek fire, sulfur and quicklime feature prominently in the Greek alchemical corpus, and notations attest to their use in explosives.[42] Although these and other Byzantine texts make some mention of Greek fire's components, the precise proportions of ingredients, as well as the mechanism of the siphon used in distributing the flammable substance, remained unclear for centuries.

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and archaeology see esp. 30 n25. On the Making and Knowing Project at Columbia University see https://www.makingandknowing.org/ (Accessed October 1, 2019).

[41] John F. Haldon and M. Byrne, "A Possible Solution to the Problem of Greek Fire," *Byzantinische Zeitschrift* 70, no. 1 (1977): 91–99.

[42] See, for example, a recipe for chrysopoeia that contains warnings about the explosiveness of quicklime, Shannon Steiner, "Nikephoros Blemmydes, Concerning Making Gold," in *Texts on Byzantine Art and Aesthetics* vol. 3 *Readings in the Visual Culture of Later Byzantium* (1081 – 1330s), ed. Charles Barber and Foteini Spingou (Cambridge: Cambridge University Press, forthcoming).

One inroad to understanding the manufacture and delivery of Greek fire has been reconstruction and reenactment, an endeavor undertaken over the course of several decades by scholars including John Haldon.[43] Haldon's reconstructions revealed close ties between the Greek fire siphon and earlier Roman hydraulics and clarified the nature of some ingredients of the incendiary mixture.[44] Reconstruction and reenactment thus allow for a glimpse into the fleeting, ephemeral stages of making that either are not documented in historical texts or were not a priority for the writers, but are still crucial for understanding a given substance, practice, or process. Like Greek fire, enameling comprised alchemical secrets, and its re-creation can provide scholars with insight into how its making unveiled those secrets.

In Byzantine alchemical texts, enameling was described as a process characterized by action, by moments of change in the physical state of its materials. These changes included the grinding and cleansing of the glass powder, and alterations in the color of the glass throughout its heating and fusion or re-solidification. Byzantine alchemical texts describe these moments in enameling as κίνησις (*kinēsis*, "movement, activation, quickening"), an aspect of enameling that Theophilus, for example, does not mention, but which was crucial in Byzantine descriptions.[45] The active, constant change

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[43] Haldon and Byrne, "A Possible Solution to the Problem of Greek Fire," 91–99.

[44] John Haldon, "'Greek Fire' Revisited: Current and Recent Research," in *Byzantine Style, Religion and Civilization: In Honour of Sir Steven Runcimen*, ed. Elizabeth Jeffreys (Cambridge: Cambridge University Press, 2006), 290–325.

[45] See Appendix II. A. A directive to fire the enamel multiple times specifies that the operation is not complete να κινήσῃ δεύτερον ὁ σμάρδος ("until the enamel quickens a second time").

witnessed during the enameling process plays out some of the most basic alchemical beliefs. For example, in his letter on gold-making, Michael Psellos is adamant that one of the key principles of alchemy that distinguishes it from magic is change in the proportion of the four elements. He writes:

> … there is nothing strange if what is more earthy becomes more watery, and what is more watery becomes airy, and what is more airy becomes fiery. So I went to the natural sciences, and I became familiar with the most prestigious philosophers, I discovered that the elements are generated reciprocally and each produces the other (in contact they act and undergo action) …[46]

Here Psellos paraphrases Plato's *Timaeus* and Aristotle's *Physics* and *Meteorology* and gives a scientific cause for transmutation.[47] He makes the key point that elemental transformation is the underlying cause of all material change, and this elemental transformation is one of the rules that governs alchemy. Transformation and transmutation are the result of elemental action that determines the structure and form of

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[46] Ὠιμην γὰρ ὡς, εἰ τὸ πῦρ ἀὴρ γίγνοιτο καὶ ὁ ἀὴρ ὕδωρ καὶ τὸ ὕδωρ γῆ καὶ τὸ αὐτὸ ἀνταποδιδοίη ἡ ἐκ τῶν κάτω πρὸς τὰ ἄνω μεταβολή, οὐδὲν καινὸν ἂν εἴη εἰ καὶ τὰ μὲν γεηρότερα ὑδατωδέστερα γίγνοιτο, ταῦτα δὲ ἀερώδη, κἀκεῖνα έμπύρια. Οὕτω τοίνυν εἰς τὴν φυσικὴν ἀναβὰς ἐπιστήμην καὶ τοῖς τελεωτέροις τῶν φιλοσόφων καθομιλήσας, εὗρον ὡς ἐξ ἀλλήλων τε τούτοις ἡ γένεσις καὶ θάτερον γεννᾷ θάτερον (παράλληλα γὰρ κείμενα πάσχει τε καὶ ποιεῖ) … For full translation and commentary see Appendix I.

[47] Francesca Albini, *Michele Psello: La Crisopea ovvero come fabbricare l'oro* (Genoa: Edizioni culturali internazionali, 1988); Gianna Katsiampoura, "Transmutation of Matter in Byzantium: The Case of Michael Psellos, the Alchemist," *Science & Education* 17, no. 6 (2008): 663–68.

matter. The "activation" or "movement" of enameling at each successive stage is the indication that matter has changed.

The first action of the enameling process is found in the preparation of glass.[48] The enameller must first grind the glass to a powder, usually employing a mortar and pestle. This is followed by a wash with clear water to separate impurities from the ground enamel. At first glance, this grinding and cleansing appears to be simply an aspect of glass-handling. Glass cannot melt evenly in large chunks, and so must be broken down. The glass color must be clear and free of contaminants. However, within the alchemical tradition, cleansing and grinding, or ταριχεία (*taricheia*, "maceration"), was a necessary phase of the transmutation process.[49] Olympiodoros begins his commentary, fittingly

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[48] One notable parallel between the *Schedula* of Theophilus and the discussion of enamel in Byzantine alchemical texts is the potential for enamel glass to be recycled from older mosaic glass. Theophilus mentions, "In the ancient buildings of pagans, various kinds of glass are found in the mosaic work – white, black, green, yellow, blue, red, and purple. They are not transparent, but opaque like marble, and are like little square stones. From these, enamels are made in gold, silver, and copper." See C. R. Dodwell, *Theophilus, the Various Arts* (London: Thomas Nelson and Sons Ltd., 1961), 44. As noted in the Introduction to this dissertation, an analysis of Byzantine enamels in the collection of the British Museum in London revealed that enamel glass bore no compositional relationship to contemporary Byzantine mosaic glass, but was instead matched the formula of sixth- and seventh-century CE wall mosaic tesserae. See Ian C. Freestone, S.G.E. Bowman and C. P. Stapleton, "Composition and Origins of Byzantine and Early Medieval Enamel Glass," Unpublished research report, British Museum Department of Scientific Research File no. 6078 (2000), 20-22. I thank Ian Freestone for sharing this report with me.

[49] Cristina Viano, "Olympiodore l'alchimiste et la *taricheia*. la transformation du minerai d'or: Technê, nature, histoire et archéologie," in *Greek Alchemy from Late Antiquity to Early Modernity*, ed. Efthymios Nicolaïdis (Turnhout: Brepols, 2018), 59–69.

titled *Εἰς τὸ κατ' ἐνέργειαν ζωσίμου* (*Eis to kat'energeian Zōsimou,* "Concerning *On Action* by Zosimos"), with a description of how to perform *taricheia*, followed by an exegesis on the term. For Olympiodoros, *taricheia* refers specifically to the process of refining gold ore through levigation (the grinding of ore with water in order to separate the metal from slag).[50] As he asserts, the most important aspect of *taricheia* is the separation of a material into its disparate parts (i.e., metal and slag). Breaking down a substance allowed for it to be cleansed, or washed, for the purpose of future melting and recombination in a purer form. The concept of *taricheia* represents an initial stage of dissolution in matter's inevitable transformation to a more perfect state. Olympiodoros' notion of *taricheia* applies specifically to the practice of refining gold. However, throughout the alchemical corpus, other excurses on *taricheia* are more general. Zosimos, for example, characterizes the act of *taricheia* as the creation of an opportunity for matter to act.[51] Therefore, when an enameller separated glass into particles through grinding and washing, he enacted *taricheia*. The preparation of enamel glass was more than an acquiescence to the demands of material physics; it was also an action upon matter that initiated its transformation.

Transmutation could begin with *taricheia*, but cues as to the continued change of matter were also important. In the Greek alchemical corpus, perhaps no action is more discussed than that of color change. Color change occupied authors as early as Pseudo-Democritus (c. first century CE) and as late as Michael Psellos (eleventh century CE). Color change represented a tangible, observable difference in the qualities of matter, and

[50] Viano, "Olympiodore l'alchimiste," 57.

[51] Viano, "Olympiodore l'alchimiste," 58-59.

in alchemical thought, operated as a hierarchy, with certain colors indicating a greater degree of material refinement. Discussion of color change took the form of treatises on dyes and washes, or, in more philosophically-inclined texts, commentary on the state of matter as it strives towards perfection is couched in terms of matter's color.[52] The stages of color change proceed from black to white to yellow, and, finally to ἴωσις (*iōsis*, "rusting" [i.e., metallic oxidation], or "iridescence"). Scholars have sometimes defined the final stage, *ios*, as "red," or "purple," but in fact it represents a change to many or all colors.[53] As matter proceeded to change color in this sequential order, each transformation brought it to a state of greater perfection.

The phenomenon of color change – one of the most easily observed transformations in making enamel – carried conceptual weight among Byzantine thinkers. Enamel glass changes color when heated, and again as it cools down, often right in front of the eyes of its maker. In our reconstruction, for example, a pale rose powdered glass turned bright scarlet when subjected to heat and the color remained, whereas green glass turned yellow and turned back to green as it cooled (Fig. 24). In our experience, the color change marked the moment of fusion of glass to metal, meaning that color change is not just incidental to enamel but is a key signal in its completion. Although the color

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[52] R. Pfister, "Teinture et alchimie dans l'Orient hellénistique," *Seminarium Kondakovianum* 7 (1925): 1–59; A.J. Hopkins, "Transmutation by Color: A Study of Earliest Alchemy," in *Studien zur Geschichte der Chemie. Festgabe Edmund O. v. Lippmann zum siebzigsten Geburstage*, ed. Julius Ruska (Berlin: Deutsche Gesellschaft für Geschichte der Medizon und der Naturwissenschaften, 1927), 9–14.

[53] See for example F. Sherwood Taylor, "A Survey of Greek Alchemy," *The Journal of Hellenic Studies* 50 (1930): 109-39, 133 n22.

change in enamel does not necessarily follow the same sequence outlined in the alchemical texts, it is nonetheless a crucial moment of action that indicates successful transformation. Moreover, when completed, the enamel is a multicolored material, recalling the notion of *ios* as many- or all-colored. As in alchemy, color change in enameling is a sign of changes in the physical state of matter and an action that testifies to its effective transmutation.

Because making was inseparable from knowing in Byzantine alchemical practice, and because enameling accomplishes multiple alchemical goals in the course of its work, the finished enameled object is not just a made-thing but also a manifestation of the knowledge required to produce it. In fact, because enamel enacted so many alchemical goals during its production, including physical state change and fusion, it may be seen as a demonstration of alchemical success and prowess simply by having been made. The enameled object shares this in common with the alchemical texts themselves, which express knowledge through the description of processes. This knowledge, which ultimately amounts to the command over matter itself, was as important visually and materially as it was verbally.

Enamel as Aestheticized Technology

If making was a way to show knowledge in Byzantine alchemical practice, then the question remains as to how that knowledge is manifest in the finished work of art. As an aestheticized technology, enamel conveys beauty through its made-ness, precisely because making had an epistemological value that brought enjoyment to the user or viewer. Historian of modern and contemporary art, Ann-Sophie Lehmann, has studied how particular combinations of materials and manufacturing processes result in objects that showcase their process of making. Seeing this making, viewers identify and empathize with the maker and take pleasure in their own recognition of how the object was made. As Lehmann explains:

> Watching making therefore becomes a form of participation…People who are skilled in a craft will be the best at appreciating the result, because they are better at deducing the actions that preceded the finished object and they have material knowledge of the stuff involved. But even if we have only rudimentary experience with clay or paint or making marks on paper, we are able to add the creative actions roughly. All this explains why procedures of skilled and creative practice are represented and why we like to watch them. 'Showing making' and looking at making is important because it is a source of both knowledge and pleasure.[54]

[54] Lehmann's study focuses on the Japanese *kikuneri* method of kneading clay and its indexical representation in the work of contemporary artist Trees de Mits. She looks not only at de Mits' final objects, but also at photographic representations of de Mits in the process of making. Lehmann is careful to acknowledge that even objects without direct

In Lehmann's model, the made object is the sum total of the series of actions that created it. Recognition of these actions is a kind of privileged knowledge that invites the viewer to share in the creative process alongside appreciation of the finished work. I propose that similarly in Byzantium, the enameled object cannot have come into being without realizing important alchemical goals, thus compelling its viewers to identify its creation with their own alchemical knowledge, or at least with recognizing the alchemical knowledge of those involved in the object's production. The aesthetic appreciation of enamel was contingent upon distinguishing the broader implications of the technology used to make it. I speculate that the alchemical processes that brought enamel into being were a key aspect of its perceived beauty, and artisans were motivated to build indicators of made-ness into completed objects.

This appreciation of made-ness, integrally bound up in alchemical achievement, is recounted in a ninth-century text, *Διήγησις περὶ τῆς οἰκοδομῆς τοῦ ναοῦ τῆς Μεγάλης τοῦ Θεοῦ Ἐκκλησίας τῆς ἐπονομαζομένης ἁγίας Σοφίας* (*Diēgēsis peri tēs oikodomēs naou tēs Megalēs tou Theou Ekklēsias tēs eponomazomenēs agias Sophias*, "Narrative About the Construction of the Temple of the Great Church of God which Is Called Hagia Sophia"), which is known in contemporary scholarship as the *Narration on Hagia*

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documentation of their manufacture can display aspects of their making, especially ceramic, metalwork, and painting. See Ann-Sophie Lehmann, "Kneading, Wedging, Dabbing and Dragging. How Motions, Tools and Materials Make Art," in *Folded Stones: Tied Up Tree*, ed. Trees de Mits and Barbara Baert (Ghent: Acco, 2009), 41–60.

Sophia.[55] The *Narration* relates in fantastical language the story of how emperor Justinian I (r. 527 – 565) constructed Hagia Sophia.[56] The anonymous author places great emphasis on the splendor of the materials used in the building's decoration, alongside the ingenious and deliberate manipulation of materials into patterned wall revetment, flooring, and liturgical objects and furnishings. Crucial to the author's ekphrastic structure are passages that evoke awe and wonder through the combination of knowledge and materials responsible for the all-encompassing majesty of Constantinople's most important church. Chapter 17 describes the construction of an elaborate altar and platform from a plethora of precious materials:

> [Justinian] also commissioned the following device [μηχανὴν (*mēchanēn*)]: Wishing to make the altar table greater and more precious than gold, he called for many experts [ἐπιστήμονας (*epistēmonas*)] and told them this. They said to him: "Let us place in a smelting-furnace gold, silver, various precious stones, pearls and mother of pearl, copper, electron, lead, iron, tin, glass, and every other metallic substance." Having ground all these all together in mortars and bound them up, they poured them into the smelting-furnace. After the fire had kneaded together [these substances], the craftsmen removed them from the fire and poured them into a mold, and so the altar-table was cast, a priceless mixture [πάμμιγος ἀτίμητος (*pammigos atimētos*)]. In this way he set it up, and underneath it he placed columns of pure gold with precious stones and enamels; and the stairs all round upon which the priests stand to kiss the altar table he made

[55] Theodor Preger, ed., "Anonymi Narratio de aedification templi S. Sophiae," in *Scriptores originum Constantinopolitanarum* (New York: Arno Press, 1975), 82-85.
[56] For an overview of the dating and scholarship surrounding the *Narration*, see Stephanos Efthymiadis, "*Diegeseis* on Hagia Sophia from Late Antiquity to Tenth Century Byzantium," *Byzantinoslavica* 73 (2015): 7–22.

> of pure silver. As for the *thalassa* [literally, "sea," but here a vessel used either for rinsing eucharistic chalices or catching drops of wine that have dripped onto the altar] of the altar table, he made it of priceless stones and gilded it. Who can behold the appearance of the altar table without being amazed? Who indeed can comprehend it as it changes color and brilliance, sometimes appearing to be gold, in other places silver, in another gleaming with sapphire – in a word, reflecting seventy-two hues according to the nature of the stones, pearls, and all the metals?[57]

Initially this passage reads as a simple account of a supremely luxurious object. The altar

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[57] Ἐποίησε δὲ μηχανὴν τοιαύτην· βουλόμενος γὰρ κρείττονα τὴν ἁγίαν τράπεζαν καί πολυτελεστέραν ποιῆσαι ὑπὲρ χρυσίου προσεκαλέσατο ἐπιστήμονας πολλοὺς είρηκὼς αὐτοῖς τοῦτο. Οἱ δὲ ἔφησαν αὐτῷ· "εἰς χωνευτήριον ἐμβάλωμεν χρυσόν, ἄργυρον, λίθους τιμίους καὶ παντοίους καὶ μαργαρίτας καὶ ζάμβυκας, χαλκόν, ἤλεκτρον, μόλιβδον, σίδηρον, κασσίτερον, ὕελον καί λοιπὴν πᾶσαν μεταλλικὴν ὕλην·" καὶ τρίψαντες ἀμφότερα αὐτῶν εἰς ὅλμους καὶ δήσαντες, ἐπὶ τὸ χωνευτήριον ἔχυσαν. Καὶ ἀναμαξάμενον τὸ πῦρ, ἀνέλαβον ταῦτα οἱ τεχνῖται ἐκ τοῦ πυρὸς καὶ ἔχυσαν εἰς τύπον· καὶ ἐγένετο χυτὴ πάμμιγος ἡ ἁγια τράπεζα ἀτίμητος· καὶ εἶθ'οὕτως ἔστησεν αὐτήν· ὑποκάτω δὲ αὐτῆς ἔστησε κίονας καὶ αὐτοὺς ὁλοχρύσους μετὰ λίθων πολυτελῶν καὶ χυμεύσεων, καὶ τὴν πέριξ κλίμακα, ἐν ᾗ ἵστανται οἱ ἱερεῖς εἰς τὸ ἀσπάσασθαι τὴν ἁγίαν τράπεζαν, καὶ αὐτὴν ὁλοάργυρον. Τὴν δὲ θάλασσαν τῆς ἁγιας τραπέζης ἐξ ἀτιμήτων λίθων πεποίηκε καὶ κατεχρύσωσεν αυτήν. Τίς γὰρ θεάσηται τὸ εἶδος τῆς ἁγίας τραπέζης καὶ οὐκ ἐκπλαγείη; ἢ τίς δυνήσηται κατανοῆσαι ταύτην διὰ τὸ πολλὰς χροιὰς καὶ στιλπνότητας ἐναλλάσσειν, ὡς ὁράσθαι τὸ ταύτης εἶδος ποτε μὲν χρυσίζον, ἐν ἄλλῳ δὲ τόπῳ ἀργυρίζον, εἰς ἄλλο σαμφειρίζον, ἐξαστράπτον καί ἁπλῶς εἰπεῖν ἀποστέλλον οβ' χροιὰς κατὰ τὰς φύσεις τῶν τε λίθων καὶ μαργαρίτων καὶ πάντων τῶν μετάλλων. Translation adapted from Albrecht Berger, trans., *Accounts of Medieval Constantinople: The Patria* (Washington, D.C.: Dumbarton Oaks, 2013), 257-59.

is imperially commissioned and fashioned from every type of precious material valued in Byzantine culture. The text's celebration of opulence and material splendor fits well into the genre of ekphrasis.[58] The *Narration* echoes earlier texts praising Justinian's lavish commissions in Hagia Sophia, particularly the well-known account of Paul the Silentiary (d. 575-580), who likewise described Justinian's commission of a sumptuous, albeit only silver, altar table.[59]

Where the *Narration* diverges from its predecessors, however, is in its emphasis on the altar table as a made-thing. Rather than framing the altar as a product of naturally occurring substances, the author presents it as the result of human ingenuity and specialized knowledge. The table is called first a μηχανὴν (*mēchanēn*), meaning "device" or "contrivance," a word with scientific overtones that implies something man-made. To create this "device," the emperor requires advising from experts, ἐπιστήμονας (*epistēmonas*), literally the "knowledgeable ones." Making in this instance thus demands not only rare and costly materials, but also keen expertise in how matter operates. While it may appear that the list of materials that make up the table is an indiscriminate conglomerate of precious stuff, the author is careful to mention that the experts call for

[58] On the *Narration* as ekphrasis see Leslie Brubaker, "Talking about the Great Church: Ekphrasis and the *Narration on Hagia Sophia*," in *Ekphrasis. La représentation des monuments dans les litératures byzantines et byzantino-slaves, Réalités et imaginaires.*, ed. Vladimír Vavřínek, Paolo Odorico, and Vlastimil Drbal (Prague: Slovanský ústav: Euroslavica, 2011), 80–87.

[59] Ruth Macrides and Paul Magdalino, "The Architecture of Ekphrasis: Construction and Context of Paul the Silentiary's Poem on Hagia Sophia," *Byzantine and Modern Greek Studies* 12 (1988): 47–82.

πᾶσαν μεταλλικὴν ὕλην (*pasan metallikēn hylēn*, "every metallic substance"). Indeed, base metals such as copper, lead, and tin are included in the list alongside gold, silver, and gems. Even glass is incorporated. All of the materials listed were understood as solids that could turn liquid and were fusible; that is to say, that while to modern readers the materials seem unrelated, they were all part of the same alchemical order of fusible matter. The materials are valuable, but more importantly they share physical properties. Once more, fire is the active elemental agent that "kneads" disparate materials into a single unified substance. Here the author shows familiarity with Byzantine understanding of how to transform matter as vocalized by the "experts." This knowledge of matter is articulated through the smelting process that follows. Precious, raw materials are not enough to make Justinian's altar table; the emperor must command knowledge of transformative processes as well.

The table manifests this command of knowledge through the author's next point of emphasis, namely the final product's changing reflectivity, color, and brilliance. Scholars have long argued that this phenomenon, known in Byzantium as ποικιλία (*poikilia*, "variety" or "variegation") was a key component in Byzantine aesthetics.[60]

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[60] Liz James, *Light and Colour in Byzantine Art* (Oxford: Clarendon Press, 1996), 125–30; Liz James, "Colour and the Byzantine Rainbow," *Byzantine and Modern Greek Studies* 15 (1991): 66–94; Liz James, "Color and Meaning in Byzantium," *Journal of Early Christian Studies* 11, no. 2 (2003): 223–33; Rico Franses, "When All That Is Gold Does Not Glitter: On the Strange History of Viewing Byzantine Art," in *Icon and Word: The Power of Images in Byzantium: Studies Presented to Robin Cormack*, ed. Liz James and Anthony Eastmond (Burlington: Ashgate, 2003), 13–24; Bissera Pentcheva, "The Performative Icon," *The Art Bulletin* 88, no. 4 (2006): 631–55; Bissera Pentcheva, "Moving Eyes: Surface and Shadow in the Byzantine Mixed-Media Relief Icon," *RES:*

Color and light were each necessary for the appreciation of the other, and dynamic color and reflectivity were crucial indicators of true form and lifelikeness.[61] *Poikilia* could be realized through any number of artistic strategies, but a common approach in Byzantium was by combining disparate materials in a single work. Previous studies have considered mixed-media in Byzantium from the vantage of completed objects, such as icons and liturgical vessels made from combinations of precious metals, gems, and textiles.[62] In the description of the altar table, however, craftsmen quite literally melted and mixed materials together before further augmenting their finished creation. The altar table is not just mixed-media but also a *made composite* that embodies *poikilia* in a single substance and brings together and displays all the desirable features of its constituent materials. In this case, *poikilia* is more than just the result of the combination of disparate precious materials. Unlike a mixed-media work, in which different materials are simply attached to one another, the altar table resulted from the irreversible transformation and fusion of materials. Moreover, the whirlwind variation of the altar table's appearance points back to the cumulative expertise and processual actions that brought the table into being. It is this man-made, variegated and fused material that the author lauds as a wonder.

Knowledge once more becomes a pivotal aspect of the altar's beauty when the

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Anthropology and Aesthetics, no. 55/56 (2009): 222–34; Bissera Pentcheva, *The Sensual Icon: Space, Ritual, and the Senses in Byzantium* (University Park: The Pennsylvania State University Press, 2010), 140.

[61] James, *Light and Colour in Byzantine Art*, 131-35; James, "Colour and the Byzantine Rainbow," 80-85; James, "Color and Meaning in Byzantium," 225-27.

[62] Pentcheva, "The Performative Icon," 631–55; Pentcheva, "Moving Eyes," 222–34; Pentcheva, *The Sensual Icon*, 121-43.

author asks who can gaze upon the table οὐκ ἐκπλαγείη (*ouk ekplageiē*), "without being amazed." He asks who can "comprehend" the altar table, and has chosen the word κατανοῆσαι (*katanoēsai*), where the prefix κατα (*kata*) intensifies the verb "νοῆσαι (*noēsai*), "to understand." The author sets up a dynamic in which some viewers know how the table was made, and thus how it appears, while others do not. Those who know are, of course, the emperor and his experts. Only viewers privileged with the knowledge of matter and making can behold the altar table and take pleasure in its made-ness precisely because *they know* how it was made. Those who do not know must remain amazed, though they too take pleasure in their amazement. This sentiment mirrors that of Psellos in his description of the petrified root, which he marveled at before he knew how it was made, but took pleasure in explaining once he understood the process of its transformation.

While aspects of the *Narration* seem fantastic, it is possible that the text might describe more than a fanciful myth. Evidence suggests that a magnificent mixed-media altar table once existed in Hagia Sophia, and that perhaps enamel was the spectacular material from which the table was made. In his *Synopsis historion*, the twelfth-century chronicler George Kedrenos paraphrased the *Narration* and added further detail, noting a dedicatory inscription on the altar table. However, Kedrenos attributed its commission not to the church's initial construction but rather to the aftermath of the earthquake of 558 that destroyed the first dome of the church.[63] This attribution places the construction of the table much later in Justinian's reign and reinforces the fictional nature of the

[63] George Kedrenos, *Synopsis historion*, in Immanuel Bekker, ed. *Georgius Cedrenus Ioannis Scylitzae ope,* vol. 1 (Bonn: Weber, 1838), 677-78.

Narration's account. Likewise, in the thirteenth century, Niketas Choniates lamented the destruction of the altar table of Hagia Sophia during the Latin conquest of Constantinople in 1204. He reiterated the splendor of the table and described it as "fashioned from every kind of precious material and fused by fire into one whole – blended together into a perfection of one multicolored thing of beauty, truly extraordinary and admired by all nations."[64] Given that accounts of the altar table post-date its supposed commission, and given that the Byzantines did not make enamel in earnest until the ninth century, it would be easy to consider Justinian's altar to be apocryphal. Another possibility, however, is that both the author of the *Narration* and George Kedrenos sought to re-write the history of a real thing, ascribing an enameled altar table produced in the middle Byzantine period to an illustrious, earlier era.

It is no coincidence that Justinian is the emperor credited with the table's commission because by the tenth century, Justinian was closely associated with alchemy. The contents list of the earliest extant alchemical manuscript, the tenth- or eleventh-century Biblioteca Marciana MS gr. 299, records a number of texts attributed to Justinian, which are now preserved only in fragments.[65] The fifteenth-century manuscript Paris gr. 2327 also records an excerpt titled Χρῆσις Ἰουστινιανοῦ βασιλέως (*Chrēsis Ioustinianou Basileōs*, "Operation of Emperor Justinian"). This brief extract of a longer treatise details how to change the colors of metals, a process which involves *taricheia*, followed by the

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[64] …τὸ ἐκ πασῶν τιμίων ὑλῶν σύνθεμα συντετηγμένων πυρὶ καὶ περιχωρησασῶν ἀλλήλαις εἰς ἑνὸς ποικιλοχρόου κάλλους ὑπερβολήν, ἐξαισίου τῷ ὄντι καὶ ἀξιαγάστου παρ' ἔθνεσιν ἅπασι. Originally edited in J. van Dieten, *Nicetae Choniatae historia, pars prior* (Berlin: De Gruyter, 1975), 573

[65] *CAAG* I:176.

application of liquid and heat to dry powders, and, finally, the reunification of substances through fusion that produces colored metals.[66] In the *Operation of Emperor Justinian* the goal to break down and recombine substances to create colorful fused metals recalls the alchemical processes of grinding, kneading, and casting necessary to fabricate the altar table in the *Narration.* With Justinian so closely aligned with alchemy, and his alchemical prowess associated with actions that also played out in enameling, it is quite possible that the *Narration* and subsequent accounts fabricated an alchemical history for a table composed at least partly of enamels.

That the table was made from enamel to some degree is supported further by the *Suda* lexicon in the entry for ἤλεκτρον (*ēlectron*), a word that could mean either "alloy, amber, or enamel," and generally seems to have designated materials that were once liquid but then solidified. The entry reads "gold of a different type, mixed with glass and stone. The [altar] table of Hagia Sophia is of this material."[67] In the case of the altar table, enamel is likely the meaning of *ēlectron* when understood as gold with glass. Indeed, enamel is mentioned using the word χυμεύσεων (*chymeuseōn*, "enameled") in the *Narration*'s account of the altar as part of the columns that hold up the table. The mixed-media columns in the *Narration* call to mind extant sixth-century inlaid columns, such as those that once occupied the east end of the church of Hagios Polyeuktos in Constantinople (Fig. 25). These opulent columns were set with amethyst and green and

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[66] *CAAG* III:384-85.

[67] Ἤλεκτρον: ἀλλότυπον χρυσίον, μεμιγμένον ὑέλῳ καὶ λιθίᾳ. οἵας ἐστὶ κατασκευῆς ἡ τῆς ἁγίας Σοφίας τράπεζα. "Electron," *Suda* Online. Tr. Peter Green. January 12, 2000. June 28, 2019 <http://www.stoa.org/sol-entries/eta/200>.

gold glass to produce a vibrant jeweled effect, as seen in the ornate gemmed columns that frame a mosaic portrait of Justinian himself in Ravenna (Fig. 26). Even if the *Narration*'s iteration of the altar table is a fiction, it is grounded in the reality of an actual form of Byzantine art-making, but the addition of enamel shows that the author of the *Narration* was motivated by a desire to associate alchemical knowledge with both visual pleasure and imperial power. It is this medium, this "alchemical work," that constitutes the literal "foundation" of the wondrous object.

Visualizing Making: The Martvili Cross

The aesthetic experiences of wonder, knowledge, and pleasure found in the description of Justinian's altar in the *Narration* also played out in actual objects. The treasury of the Georgia State Museum of Fine Arts in Tbilisi houses an enameled pectoral cross that was once part of the inventory of the monastic complex of Martvili in the region of Svaneti in the northwest of Georgia (Fig. 27).[68] The cross is a magnificent composition of gold, sunk enamel, gemstones, and pearls. Enamel works tend to be relatively small because of physical limitations of the material, which cause it to crack or shatter when produced on a large scale. At 16 x 9.5 cm the Martvili cross is remarkably large. The obverse of the cross depicts busts of the Virgin Mary, Saint Demetrios, Saint Nicholas, and a full-length

[68] It is commonly referred to as the "Second Pectoral Cross from Martvili," an epithet that acknowledges another large pectoral cross from the inventory at Martvili, which is also made of enamel with gold repoussé figures. See Leila Z. Xuskivadze, *Medieval Cloisonné Enamels at the Georgian State Museum of Fine Arts* (Tbilisi: Xelovneba, 1984), 28–29, 116. In what follows, I do not discuss the "first" cross from Martvili, and therefore refer to the "second" cross from Martvili as simply "the Martvili cross."

portrait of Saint John Chrysostom. Overall the cross elicits a kind of paradoxical looking. The bright colors and sumptuous surfaces create a dazzling effect, prompting the viewer's eye to jump from detail to detail. At the same time, the stark, unornamented gold planes of the cross itself highlight the figures, encouraging sustained contemplation of the holy persons portrayed. This juxtaposition recalls the whirlwind description of viewing Justinian's altar table and suggests that part of the pleasure in beholding the Martvili cross was allowing oneself to be amazed by it.

Questions of provenience plague enameled objects in Georgian collections, and the location of the Martvili cross' production in either Georgia or Byzantium remains debated.[69] A Constantinopolitan provenience for the Martvili cross is supported by close parallels in the figural enamel to a pectoral cross now in the British Museum, which is

[69] In studies of the national collections of Georgia, the Martvili cross has been attributed to Georgian production on the grounds that its figures resemble ninth-century objects with inscriptions in Georgian, such as a quatrefoil once owned by the Russian artist and collection Mikhail Botkin (1839-1914). Over the years, however, scholars such as David Buckton have cast doubt on the authenticity of enamels in Botkin's collection. The question of where the Martvili cross was produced remains unresolved, but its medieval date is uncontested. Shalva Amiranashvili, *Medieval Georgian Enamels of Russia*, trans. Francois Hirsch and John Ross (New York: H. N. Abrams, 1964), 40; Xuskivadze, *Medieval Cloisonné Enamels*, 29; David Buckton, "Byzantine Enamels in the Twentieth Century," in *Byzantine Style, Religion and Civilisation: In Honor of Sir Steven Runciman*, ed. Elizabeth Jeffreys (Cambridge: Cambridge University Press, 2006), 25–37.

said to have been found in the vicinity of the Great Palace in Constantinople (Fig. 28).[70] Likewise, the rudimentary style of the figural enamel and the form of the cross correspond closely to another pectoral cross now incorporated into the famous Khakhuli Triptych. That cross is attributed to Byzantine production (Fig. 29).[71] It depicts the first Christian-Roman (i.e., Byzantine) emperor, Constantine I, and his mother, Helena, whom legend credits for having discovered the relic of the True Cross in Jerusalem. They are accompanied by busts of the four prophets Isaiah, Daniel, Elijah, and Elisha. Scholars have dated the Martvili cross and both of these comparanda to the mid-tenth or eleventh century on stylistic grounds.[72]

One of the most compelling features of the Martvili cross is not its figural imagery, which is typical of the cross's date and function, but rather the unique use of enamel rings of pure color at the terminal of each cross arm and in the interstices between cross-arms (Fig. 30). At the end of two cross arms, a large ring of deep translucent green with opaque red circles surrounds an amethyst, while the top and bottom rings surround empty bezels that once held stones, presumably amethysts. In the spaces between arms, smaller rings of opaque cobalt blue with gold circles surround emeralds. The repeating pattern of circles creates a series of curved lines that accentuate the angular gold field of

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[70] On the find spot of the British Museum cross, see Helen C. Evans and William D. Wixom, *The Glory of Byzantium: Art and Culture of the Middle Byzantine Era, A.D. 843-1261* (New York: Metropolitan Museum of Art, 1997), 170-71.

[71] Amiranashvili, *Medieval Georgian Enamels*, 104; Xuskivadze, *Medieval Cloisonné Enamels*, 36.

[72] Amiranashvili, *Medieval Georgian Enamels*, 40; Xuskivadze, *Medieval Cloisonné Enamels*, 29.

the cross and echo the haloes of the depicted holy figures. The rings mirror the beaded gold border that surrounds each bezel, as well as the spherical shape of the pearls. These rings employ enamel in a novel way. The lack of figural representation in the rings allows the material features of enamel to take visual precedence, but it would be a mistake to read the enameled rings on the Martvili cross as simple ornamentation or formal devices.

I propose there is subtle visual and material play at work in the enameled rings of the cross. Benjamin C. Tilghman has shown that ornament in medieval art was deeply tied to both processes of making and the communication of meaning.[73] In the case of the opaque blue rings, enamel completely obscures the gold substrate and allows no light to pass (Fig. 31). This is in contrast to the sunk enamel on the cross, where the gold takes visual precedence (Fig. 32). Instead, a viewer encounters the same opaque metallic sheen, but in bright, vibrant blue rather than shining gold. The cobalt enamel appears almost like a metal, with the gold circles inside the rings enacting even more extreme material elision. There is little sense of where metal ends and enamel begins. The transparent green rings with red circles confound the viewer as well. An expectation of soft opacity similar to that of the blue rings is countered by brilliant translucency. The green field is punctuated with opaque circles in a complementary color that is both visually harmonious and striking in its contrasting intensity (Fig. 33). The green rings present very much as glass but are intensified through the use of color and varying opacity.

Together the colored rings of the Martvili cross communicate a crucial idea – they visualize the "made-ness" of the enamel. In the blue rings, opacity is used to conflate

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[73] Benjamin C. Tilghman, "Pattern, Process, and the Creation of Meaning in the Lindisfarne Gospels," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture* 24, no. 1 (2017): 3–28.

glass with metal and dissolve the visual boundaries between enamel's two constituent materials. In the green rings, color and transparency exaggerate the most desirable qualities of glass, namely its capacity for saturated hue and reflectivity. The blue and green rings signal the manipulation of matter at work in the cross, thereby drawing attention to the process of making that remains evident in the object's materiality. In a way, the Martvili cross is much like Justinian's altar table in that it exemplifies the type of mixed-media work that medieval Byzantine viewers prized, albeit on a much smaller scale. As in the account of the altar, materials in the cross are combined into a conglomerate that dazzles with its variety, color, and shimmer. But it is the enamel, an actually *made* material, which frames the cross in its entirety and contrasts with the natural materials of stone and pearls.

Enameling is characterized both by its combination of disparate materials and by repeated shifts in the physical state of those materials. The enamel rings on the Martvili cross enact the qualities of both glass and metal, the two essential components in enameling. This endows the object with the ability to appear to be – or to be like – many materials at once. The co-action of color, luminescence, reflectivity, and forms on the cross all serve to destabilize the eye and give the object the appearance of constantly changing. This continuous transformation hearkens back to the alchemical processes that made the cross, lending it a sense of perpetually acting out its own making.

Conclusion

One of the most distinctive features of enamel is that it is not a raw material, rather it is made by human hands. Making in Byzantium was intimately tied with knowledge production, particularly knowledge of the behavior of matter. Byzantine alchemical texts equated practical experience, usually taking the form of artisanal making, with understanding the workings of the world. These texts also set up a social dichotomy in which some classes of people know how things were made and take pleasure in knowing, while others who do not know how things were made still take pleasure in their made-ness, allowing themselves to wonder and be amazed.

Making enamel was a process composed of actions that both signaled transformation and acted out important alchemical concepts, such as destruction and recomposition. In addition, color change was a crucial sign of transmutative fusion. Enameled objects possessed the capacity to enact their own making by embodying the most distinctive qualities of their constituent materials – metal and glass – through reflectivity, opacity, and dramatic contrasts of color. In the story of the altar at Hagia Sophia and in the Martvili cross, these values of making and aesthetics of technology are fully exploited, both in the textual description and in the actual object. This aligned with Byzantine aesthetic sensibilities that privileged variety and variegation, allowing viewers to take pleasure in the active, energetic made-ness of enamel.

Chapter Three

Byzantine Enamel as Artificial Replication

Enamel is a material made by human hands, and its made-ness was both a demonstration of knowledge and a source of pleasure. However, enamel was rarely employed in isolation. Extant Byzantine enameled objects were once affixed to cloth, metal, and stone. This put enamel in constant dialogue with natural materials, as exemplified by the ninth- or tenth-century Stoclet paten, a small round dish (12.3 cm diameter) used to hold the eucharistic host during the liturgy (Fig. 34).[1] The paten is constructed from a single deep brown agate disk. The natural pattern of the stone is swirled throughout with bands of paler brown and white. The disk is surrounded by a gilded silver frame set with green and red gemstones, likely emeralds and garnets. Three oblong enamels with a floral motif set into the frame are later modifications, probably of French production and dated to the fourteenth century.[2] At the center of the paten, however, is an original, Byzantine *cloisonné* enamel roundel depicting the Last Supper (Fig. 35). The apostles are arranged around a semi-circular table, with Judas greedily grasping for a fish while Christ mirrors his gesture with one that indicates speech. The scene captures the palpable tension at the moment Christ acknowledges his future betrayal. Accomplished in the roundel's limited space, this miniature vignette is a remarkable feat of representation.

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[1] On the dating of the Stoclet paten see Helen C. Evans and William D. Wixom, *The Glory of Byzantium: Art and Culture of the Middle Byzantine Era, A.D. 843-1261* (New York: Metropolitan Museum of Art, 1997), 67.

[2] On the dating and technique of the three floral enamels on the paten see Jannic Durand, "Patène," *L'objet d'art de la saison* 7 (1999): 17-20.

The surfaces of the enameled roundel on the Stoclet paten have all the appearances of perfect jewels. The figures of Christ and the apostles are rendered in translucent and semi-translucent hues of sapphire blue and a pale turquoise that is reminiscent of chalcedony. The table of the Last Supper is a flat, opaque ultramarine that recalls the vibrant color of lapis lazuli. The yellow and white of the table's lobes resemble jasper and mother of pearl. The drapery that hangs from the table's surface falls in folds of rich, ruby red and carnelian. The entire scene transpires against a brilliant, saturated emerald green background. The medallion is set in a heavy gold bezel much like the gemstones on the frame. It is circled by a gold beaded border.

The enamel's similarity to gemstones is disrupted, however, by the graphic delineation of the bodies of Christ and his disciples. The gold *cloisons* interrupt the jewel tones, arranging them into figural representation. Although now damaged and pitted with age, the enamel would have originally been smooth, faultless, and gleaming. Indeed the glass fill's stark uniformity of color and texture would have superseded the surrounding gems, which show natural irregularities. Due to their inherent properties of crystalline structure and cleavage, natural stones cannot achieve the fluidity of enamel's curved forms. The perfection of enamel in both its pictorial and material aspects announces what separates it from the gems it resembles: its artificiality.

This chapter delves deeper into the made-ness of Byzantine enamel by considering the specific kinds of knowledge that enameling enacted, particularly knowledge of the functions of nature. I examine two sets of instructions for enameling in the Greek alchemical corpus that characterize enamel as an artificial gemstone, but one which surpasses the power and beauty of natural stones. I argue that in these texts, the

enameling process is characterized as a type of artificial replication that imitated natural processes of generation. Enamel did not replicate nature illusionistically, rather it imitated nature's mechanics. Through human intervention in these replicative processes, enameled objects assumed the appearance of their natural prototypes.

I begin the chapter by considering Byzantine notions of artificiality. Byzantine authors classified certain types of processes and their outcomes as χειρόκμητα (*cheirokmēta*) meaning literally "wrought by hand," but more generally "artificial."[3] A capacious term, *cheirokmēta* referred to everything from medicines derived from herbs to sculpture to alchemical processes.[4] Anything processed or manipulated by human intervention could count as *cheirokmēta*. In contemporary culture, artificiality carries connotations of deception and inauthenticity. In Byzantium, however, artificial imitations of nature were crucial to explaining how the natural world worked. Esteemed classical philosophers, in particular Aristotle, argued that replicating natural processes made artificial products equivalent to natural ones. Alchemical texts posited that artificial imitations were equal to, or could even surpass, natural substances in value. Byzantine artisans also made use of artificial materials, such as glass, to enhance the appearance of costly jewelry and lapidary work. Taken together, the evidence supplied by Byzantine philosophy, alchemy, and artistry characterizes artificiality as a useful, even desirable quality.

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[3] For a discussion of the definition and historical dimensions of the term *cheirokmēta*, see Matteo Martelli, ed., *The Four Books of Pseudo-Democritus* (Leeds: Maney Publishing, 2013), 44-47.

[4] Martelli, *The Four Books of Pseudo-Democritus*, 47.

The following section explores how the process of enameling was understood to mimic the generation of stones deep within the earth. Byzantine thinkers inherited their comprehension of geological formation from Classical authors, including Plato, Aristotle, and Theophrastus. In the works of these philosophers, stones were composed of earth and water, compressed in layers and changed through contact with fire. In enameling, glass – itself made of sand and thus "earth" – is mixed with water, fired, and built up layer upon layer much like a stone on a smaller scale. On the one hand, this straightforward replication demonstrated a functional knowledge of how stones were made. On the other, human artisans could intervene in enameling in a way that they could not with natural stones, and thus manipulate effects of color, translucency, and, of course, representation.

I next examine how Byzantine enamel was classified as an artificial gemstone. Two recipes for enamel in the alchemical corpus elide enameling with the creation of artificial stones. At the same time, extant enamels invite close comparison to gemstones in their qualities of color and in the framing structures used when they are set in a mixed media work. I argue that this material mimesis was a deliberate act. By placing artificial enamel side-by-side with natural gemstones or augmenting enamel as if it were a gem itself, Byzantine artisans drew attention to their ability to engineer mundane glass and metal to replicate natural precious stones. It is easy to dismiss enamel as an inexpensive substitute for rare stones. However, I argue that this artificial replication was, in fact, a means to display human ingenuity.

The chapter concludes with a close look at the relationship between enamel and natural stones as manifest in a collection of liturgical vessels now in the Treasury of San Marco (Venice). Made of sumptuous sardonyx and alabaster, the vessels all feature

frames, bases, or medallions made from enamel. As framing devices or central roundels, the enamels enhance the beauty of the natural stone vessels. The enamels also surround and interrupt the stone with images of Christ and the saints, representing divine dominance over the natural world through human artifice.

Byzantine Notions of the Artificial

In Pliny the Elder's *Natural History*, the author complains at length about frauds who process gemstones and turn one type of stone into another:

> To distinguish genuine and false gemstones is extremely difficult, particularly as men have discovered how to make genuine stones of one variety into false stones of another. For example, a sardonyx can be manufactured so convincingly by sticking three gems together that the artifice cannot be detected: a black stone is taken from one species, a white from another, and a vermilion-colored stone from a third, all being excellent in their own way. And furthermore, there are treatises by authorities, whom I at least shall not deign to mention by name, describing how by means of dyestuffs emeralds and other transparent colored gems are made from rock-crystal, or a sardonyx from a sard, and similarly all other gemstones from one stone or another. And there is no other trickery that is practiced against society with greater profit. [5]

Pliny's focus on duplicitousness and trickery has done much to buttress modern assumptions about ancient and medieval notions of artificiality. What is artificial cannot be genuine, and what is artificial is also antithetical to nature. Pliny's objections,

[5] Pliny the Elder, *Natural History*, Book 27, trans. D. E. Eichholz (Cambridge, Mass.: Harvard University Press, 1938), 326–27.

however, are outliers. Attitudes towards the artificial in Byzantium, inherited from Classical philosophy, were more positive.

In book four of Aristotle's *Meteorology*, the philosopher describes different behaviors of natural heat. He details the operations and differences between boiling and scalding (moist heat) and roasting (dry heat). At the end of his discussion, he makes an observation to distinguish between the natural and the artificial:

> Roasting and boiling are, of course artificial processes, but, as we have said, in nature too there are processes specifically the same; for the phenomena are similar though we have no terms for them. For human operations imitate natural.[6]

This brief passage makes two compelling points. First, artificial processes are analogous to natural ones. Second, because of that analogy, artificial processes are instruments for understanding natural processes. Aristotle discerns that humans have no terms for some natural processes, and so those natural processes are best comprehended through their artificial parallels. As Bernadette Bensaude-Vincent and William R. Newman have pointed out, this passage from Aristotle complicates and, in effect, breaks down the boundaries between the natural and the artificial:

> If we take the emphasis off the product itself and focus on its mode of production, then we can say that something as seemingly unnatural as glass is actually a product of nature. After all, by one interpretation of *Meteorology* the heat employed in fusing sand and alkali together into a

[6] ὄπτησις μὲν οὖν καὶ ἕψησις γίγνονται μὲν τέχνῃ, ἔστιν δ', ὥσπερ λέγομεν, τὰ εἴδη καθόλου ταὐτὰ καὶ φύσει· ὅμοια γὰρ τὰ γιγνόμενα πάθη, ἀλλ' ἀνώνυμα· μιμεῖται γὰρ ἡ τέχνη τὴν φύσιν. Aristotle, *Meteorology*, Bk 4, 381b.

> hard, clear substance is the same as the heat that melts stone in volcanoes, Since we use nature's own agencies in making glass, the product is itself natural by this line of reasoning.[7]

While Bensaude-Vincent and Newman are correct in their conclusion that, in *Meteorology,* Aristotle seems to equate the natural with the artificial, Aristotle himself was careful to point out that the natural and the artificial were different. In his *Physics*, the philosopher uses the example of a wooden bed to clarify how the artificial differs from the natural. If planted, a wooden bed would grow trees, not beds.[8] This is because the artificial is a form imposed on matter, the nature of matter itself remains unchanged. What Aristotle clarifies in his *Meteorology* is that both nature and man have the ability to impose form on matter, and the *process* by which matter is formed can be the same. To use Bensaude-Vincent and Newman's example of glass, glass is *different* from natural stone because the form "glass" has been imposed upon sand and alkali by humans and not by nature. But glass and natural stone are *equivalent* because their essential matter and processing are the same. That is to say, in Aristotle's model, artificially made substances are not lesser in value because of their artificiality. On the contrary, artificial replications of natural processes and substances demonstrated an intimate knowledge of the natural world and its functions, because to create them required an understanding of nature's physics and mechanics.

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[7] Bernadette Bensaude-Vincent and William R. Newman, "Introduction," in *The Artificial and the Natural: An Evolving Polarity*, ed. Bernadette Bensaude-Vincent and William R. Newman (Cambridge: MIT Press, 2007), 6.

[8] Aristotle, *Physics*, Bk. 2, Ch. I, 193b.

The Aristotelian view of the natural and the artificial as different but equal in value was transmitted to Byzantine thinkers through commentaries composed in late antiquity. In particular, the *Meteorology* was studied through a commentary by Olympiodoros (c. 495 – 570) – likely the same Olympiodoros whose commentary on Zosimos of Panopolis (fl. 300) survives in the Greek alchemical corpus.[9] In fact, sources both peripheral and central to Byzantine alchemy have much to share regarding how Byzantine thinkers inherited notions of the artificial. The influential alchemical authors Zosimos and Pseudo-Democritus (fl. first century CE) are both credited with composing long-form treatises on artificial materials titled *Cheirokmēta*, or "Things Wrought By Hand," which no longer survive.[10] The word *cheirokmēta* appears in the *Meteorology* to differentiate artificial wells from natural springs, and in Classical antiquity the term encompassed anything artificially made.[11] In his *Authentic Memoirs*, Zosimos used the

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[9] Wolfgang Lackner, "Die aristotelische Meteorologie in Byzanz, " in *Actes XIV congrès international des études byzantines*, vol. 3, ed. M. Berza and E. Stanescu (Bucharest: Editions de l'Académie de la République Socialiste de Roumanie, 1976), 639-43 ; Cristina Viano, "Aristote et l'alchimie grecque : La transmutation et le modèle aristotélicien entre théorie et pratique," *Revue d'histoire des sciences* 49 (1996): 189–213.

[10] The precise relationship of the word *cheirokmēta* to alchemy is difficult to discern. *Cheirokmēta* appears as the title of a work by the Egyptian philosopher, Bolos of Mendes, once believed to be the author of Pseudo-Democritean works. Yet *Cheirokmēta* is also attributed by Vitruvius and Pliny to Democritus himself. Where Zosimos is concerned, the *Suda* lexicon describes him as the author of twenty-eight books on alchemy titled *Cheirokmēta*. See Martelli, *The Four Books of Pseudo-Democritus*, 44-47.

[11] On the attestation of *cheirokmēta* in lassical texts, see Martelli, *The Four Books of Pseudo-Democritus*, 43 n243.

term to refer to soap.[12] As Matteo Martelli points out, the term *cheirokmēta* describes a kind of processing, confirming that it is once more human processing which differentiates the artificial from the natural, but there are no connotations of deception or profit to be made from the ignorance of others. To the contrary, the publication of books on *chierokmēta* by high-profile authors testifies to the circulation of knowledge concerning artificial processes and materials among the educated elite, who would have purchased and used these imitations.

Material evidence likewise evinces a familiarity with and even an affinity for artificial replications. Fine jewelry and goldsmith's works from the Byzantine period make frequent use of artificial modifications and imitations to enhance beauty and durability. A rock crystal pendant dated to the sixth or seventh century, now in the Dumbarton Oaks Collection, is one such example (Fig. 36). Carved with an image of Christ Emmanuel, the stone of the pendant is clear and mostly free of blemishes save for a few cracks due to age. The carving is detailed, and the overall quality of the workmanship is high. The back of the pendent, however, is augmented with cobalt blue glass, so that when viewed from the front its color shines through the clear crystal and gives the pendant the appearance of a sapphire. In modern goldsmithing, this practice is known as making a "doublet," and is employed either to strengthen a soft stone using a harder material or to modify and enrich a stone's color. In the pendant, the blue glass deepens the color of the negative space in relation to the carving, allowing the carved forms to stand out and take visual precedence. In the case of the Dumbarton Oaks

[12] Zosimos of Panopolis, *Les Alchimistes grecs: Zosime de Panopolis, Mémoires authentiques*, ed. Michèle Mertens, vol. 4 (Paris: Les Belles Lettres, 1995), 55–56.

pendant, an artificial material has been added to a natural one for the purpose of improving its representational capacity. This modification enhances, rather than decreases, the pendant's aesthetic impact.

With the emergence of materials analysis technologies, a number of Byzantine jewelry hoards have been studied and found to be constructed from gold and glass rather than gold and precious stones.[13] In one case, the natural and the artificial are difficult to separate. A pair of gold earrings with blue stones now in the Byzantine and Christian Museum of Athens were analyzed using Raman spectroscopy to determine their material composition (Fig. 37). The relatively simple earrings each feature two blue stones long believed to be sapphires. When tested, however, the stones were revealed to be blue glass.[14] A detailed examination of the composition of the glass found that the colorant and opacifier used was lazurite, a natural blue stone that often combines with other minerals to form lapis lazuli.[15] The presence of lazurite in the earrings is unusual because, usually, colorants and opacifiers in glass are metals, not stones. In the case of the earrings, an artificial imitation of a stone was fashioned using natural stone. This choice blurs the lines between natural and artificial and creates something approaching a true synthesis.

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[13] For example, when the seventh-century Kratigos-Mytilene treasure was analyzed using Raman spectroscopy, gemstones once believed to be emeralds registered instead as green glass. See Thomas Katsaros and Theodore Ganetsos, "Raman Characterization of Gemstones from the Collection of the Byzantine and Christian Museum," *Archaeology* 1, no. 2 (2012): 7–14.

[14] Katsaros and Ganetsos, "Raman Characterization," 13.

[15] Katsaros and Ganetsos, "Raman Characterization," 13.

In another instance, an artificial imitation assisted in creating a sense of perfection in a piece of jewelry. An elaborate earring or diadem ornament now in the National Archaeological Museum of Athens is a rich composition of gold, garnets, pearls, sapphires, emeralds, and green glass (Fig. 38). Across the bottom of the ornament is a series of seven chains, each terminating with a gold drop or a stone. The green "stone" affixed to the center chain is, in fact, green glass.[16] The other green stones on the ornament are emeralds. Why was glass used for the center chain rather than another emerald? Pliny might argue that the owner of the ornament was duped by some dishonest artisan, but a more compelling answer is that the artificial stone has a clarity and luminosity that the natural stones around it lack. The sapphires and garnets that frame the glass "stone" are roughly shaped and full of inclusions, whereas the glass is clear and formed into a drop. As the focal point of the ornament's composition, the glass drop is more perfect than the stones that surround it. Worn on the ear or near the temple, the ornament would have moved and flickered in the light and caused the glass to illuminate. In the case of the ornament, the artificial material contrasts with the natural materials around it, and actually supersedes the quality of the natural stones.

This small collection of objects – pendant, earrings, and ornament – demonstrates a pragmatic and utilitarian approach to artificial materials in Byzantine craftsmanship. While it may yet be the case that the patrons of these luxury jewels were deceived, a

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[16] Antje Bosselmann-Ruickbie, *Byzantinischer Schmuck des 9. bis frühen 13. Jahrhunderts: Untersuchungen zum metallenen dekorativen Körperschmuck der mittelbyzantinischen Zeit anhand datierter Funde* (Wiesbaden: Reichert Verlag, 2011), 239.

close look at how artificial materials were integrated into works of art reveals a degree of intentionality. Artificial materials were useful for enhancing the properties of natural substances and valuable for their ability to modify aspects such as color and clarity. Artificial materials were desirable for the ways in which their own properties surpassed or improved upon their natural prototypes. Together with the notions of artificiality inherited from Classical philosophy and alchemy, the material evidence substantiates a Byzantine view of the artificial that was tolerant if not enthusiastic. With the introduction of enamel into the Byzantine artistic canon, artisans not only exploited such enthusiasm for the artificial, they celebrated it.

Making Enamel, Imitating Nature

As discussed in Chapter 2, alchemical authors in Byzantium equated making and process with knowing, a position that echoes the stance taken by Aristotle in the *Meteorology*. As Aristotle notes, humans have no terms for certain types of natural phenomena and so must explain them using their artificial parallels. Within this paradigm, knowledge of nature is acquired through imitating its mechanics, that is, through process, and as Aristotle states, "human operations imitate natural." Therefore, it is worth asking what natural processes enameling imitated and what type of knowledge was attained.

The answer lies in an alchemical text. The text is elaborately titled *Καταβαφὴ λίθων καὶ σμαράγδων καὶ λιχνιτῶν καὶ ὑακίνθων ἐκ του ἐξ ἄδυτου τῶν ἱερῶν ἐκδοθέντος βιβλίου* (*Katabaphē lithōn kai smargadōn kai lichnitōn kai hyakinthōn ek tou ex adytou tōn hierōn ekdothentos bibliou*, "The Deep Dyeing of Stones, Green Stones, Red Stones, and Blue Stones According to the Books Taken from the Inner Sanctuary of the Temple"),

a reference to the passage in the *Physika kai Mystika* of Pseudo-Democritus, in which books of alchemical knowledge are revealed through the collapse of a column in an Egyptian temple.[17] Most likely composed between the eighth and tenth centuries, the text begins with several theoretical discourses on the colors and luminosity of stones and ends with a long series of recipes for imitation gems.[18] In the very middle of the text is a recipe for enameling:

> *On Enameling*: Take 3 liters of *syrikon,* 1 liter of clear glass, 2 *hexagia* of tin, and grind approximately one *chous* of sulfur into a fine powder. Put them in a clean small cup, and heat them over the charcoal until it becomes green glass. If the heating is extended it becomes golden; if extended even longer, white like crystal.[19]

Even if the reader possesses an intimate knowledge of enameling, the recipe is not easy to understand. It describes how to color the glass that will eventually fill the cells of an enameled work. Crucially, the inclusion of this recipe in a text dedicated to the artificial

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[17] For a translation of and fully commentary on this text, see Appendix II.B. For a discussion of the *Physika kai Mystika,* see Chapter 1.

[18] The text may, in fact, be part of the lost book on stones attributed to Pseudo-Democritus, but preceded by one or more Byzantine epitomes, see Matteo Martelli, "The Alchemical Art of Dyeing: The Fourfold Division of Alchemy and the Enochian Tradition," in *Laboratories of Art: Alchemy and Art Technology from Antiquity to the 18th Century*, ed. Sven Dupré (New York: Springer, 2014), 1–22. I thank Matteo Martelli for his thoughts on the dating of *The Deep Dyeing of Stones.*

[19] ΠΕΡΙ ΧΥΜΕΥΤΙΚΗΣ: Λαβὼν σηρικὸν λίτρας γ′, κρύσταλλον καθαρὸν λίτραν α′, κασσίτερον ἐξάγια β′, λείωσον θεῖα ὡς χοῦν· καὶ βάλε αὐτὰ εἰς χυτρίδιον ἄθικτον, καὶ παρόπτα αὐτὰ εἰς κάρβωνα, ἕως γένηται ὕαλος πράσινος. Ἐὰν ὑπάρχῃ τὸ πῦρ ἐκτεταμένον, γίνεται χρυσοειδές· εἰ δὲ ἐπὶ πλέον, λευκὸν ὥσπερ κρύσταλλος. See Appendix II.B.

creation of gems categorizes enameling within processes related to the imitation of precious stones.

The recipe in *The Deep Dyeing of Stones* provides a starting point for examining how making enamel was a process of imitating nature. The *syrikon* mentioned in the text is an Arabic loan word for red lead oxide, an ingredient that increases the reflectivity of glass.[20] Tin is an opacifier and a yellow colorant.[21] Sulfur imparts a blue color.[22] Combined, they make clear green glass. At their most basic, these materials are a mixture of minerals, glass, and metals, all elements that conform to Byzantine understanding of the composition of natural stones. Three accounts compose the primary evidence for Byzantine understanding of the formation of stones. Plato's *Timaeus*, Aristotle's *Meteorology*, and Theophrastus' *On Stones* all discuss the ways in which gemstones and metals are generated through ratios of earth, water, heat, and cooling.[23] The authors differ

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[20] On the term *syrikon*, see Ahmad Y. Al-Hassan, "An Eighth-Century Arabic Treatise on the Colouring of Glass: *Kitāb al-Durra al-Maknūna (The Book of the Hidden Pearl)* of Jābir Ibn Ayyān (c. 721–c. 815)," *Arabic Sciences and Philosophy* 19, no. 1 (2009): 121–56.

[21] On the use of tin in Byzantine enameling, see Isabelle Biron, ed., *Émaux sur métal du IXe au XIXe siècle: Histoire, technique et matériaux* (Dijon: Éditions Faton, 2015), 154.

[22] Biron, *Émaux sur métal*, 155.

[23] The transmission of these texts to Byzantium was primarily through philosophical studies, including natural philosophy and alchemy. In the case of Plato's *Timaeus* and Aristotle's *Meteorology*, alchemy played a large role in transmitting core philosophical concepts, even if Byzantine alchemical authors did not credit Plato and Aristotle directly. In the case of Theophrastus' *On Stones*, the text survives in one thirteenth-century Byzantine manuscript and two fifteenth-century post-Byzantine manuscripts. See Cristina Viano, "Les alchimistes gréco-alexandrins et le Timée de Platon," in *L'alchimie et ses*

in their precise theorizing as to how these components form stones, and which kinds of stones, but the components remain the same. Broadly speaking, enameling shares these basic components.

In the medieval world, as in Classical antiquity, glass was considered a kind of fusible mixture of earth and water.[24] This idea has its origins in Plato's *Timaeus*, in which the philosopher states, "of these substances, those which contain less water than earth form the whole kind known as 'glass.'"[25] Likewise, in Theophrastus' *On Stones*, the philosopher explains how stones are first composed of earth: "Of the substances formed in the ground, some are made of water and some of earth. The metals obtained by mining, such as silver, gold, and so on, come from water; from earth come stones, including the more precious kinds."[26] Theophrastus goes on to explain that glass is a type of earth that has been "thickened" by fire: "It is also possible for earth to be melted and softened and hardened again. It melts <along with> substances which are dug up and which can be liquified…and if glass is also formed, as some say, from vitreous earth, this too is made

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racines philosophiques: la tradition grecque et la tradition arabe, ed. Cristina Viano (Paris: Librairie Philosophique J. Vrin, 2005), 91–108; Earle R. Caley and John F. C. Richards, eds., *On Stones. Introduction, Greek Text, English Translation and Commentary* (Columbus: The Ohio State University Press, 1956), 5.

[24] Marco Beretta, *The Alchemy of Glass: Counterfeit, Imitation, and Transmutation in Ancient Glassmaking* (Sagamore Beach, MA: Science History Publications, 2009), 31–32; E. Marianne Stern, "Glass and Rock Crystal: A Multifaceted Relationship," *Journal of Roman Archaeology* 10 (1997): 192–206,

[25] Plato, *Timaeus*, 61b.

[26] Theophrastus, *On Stones*, 1.

by thickening."[27] Within the canon of natural philosophy inherited from Classical antiquity, glass was a type of stone, made of earth and water and capable of fusion. Glass occupied a space somewhere between the natural and the artificial, as glass could occur naturally as well as being processed and made by human beings. In enameling, glass is crushed to a powder and thus reverted to its "earth" state. The addition of water, to form a kind of glass slurry, introduced the characteristic of fusibility; Plato, Aristotle, and Theophrastus all noted that some stones were fusible when their moisture was intact.[28]

Thus far, we have seen that in frameworks of natural philosophy inherited from Classical antiquity, stone is composed of earth and water. Some stones are also fusible depending on their water content and can liquify. Plato goes on to clarify that compounds of earth and water, such as stone and glass, are soluble by fire:

> As regards the classes of bodies which are compounds of earth and water, so long as the water occupies the interspaces of earth which are forcibly contracted, the portions of water which approach from without find no entrance, but flow around the whole mass and leave it undissolved. But when portions of fire enter into the interspaces of the water they produce the same effects on water as water does on earth; consequently, they are the sole causes why the compound substance is dissolved and flows.[29]

The above passage details how water will not dissolve compounds of earth and water, but fire will, providing an explanation for the liquification of materials like glass and enamel when subjected to heat. Aristotle is perhaps clearer, and observes that, "Everything that solidifies is (1) a watery liquid or (2) a compound of water and earth, and the cause is

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[27] Theophrastus, *On Stones*, 48-49.

[28] Plato, *Timaeus*, 61e; Aristotle, *Meteorology*, Bk 4, 378a; Theophrastus, *On Stones*, 48.

[29] Plato, *Timaeus*, 61b.

either dry heat or cold. So of things which solidify owing to hot or cold, those that dissolve are dissolved by the opposite property…those solidifying owing to cold are dissolved by fire, that is, by heat."[30] What Aristotle means is that compounds of water and earth, such as stone, are dissolved by heat and solidified by cold. This explains why "stone," such as glass, liquifies when it is melted and solidifies as it cools.

To reiterate, in the philosophy of Plato, Aristotle, and Theophrastus, stones in the earth were formed from combinations of earth and water, acted upon by heating and cooling. They liquify through the action of heat and solidify through cooling. Enamel behaves in much the same way, being first a combination of "earth," that is, glass, and water. Enamel liquifies with the application of heat and solidifies as it cools. Therefore, when Byzantine artisans made enamel, they quite literally mimicked natural processes of material combination, heating, and cooling to create an artificial stone. In the Aristotelian model of artificial substances, enameling demonstrated knowledge of the generation of stones through one-to-one imitation. The similarities between how stones were understood to generate and how enamel was made account for enamel's inclusion in a treatise centered on the creation of imitation gemstones. Where enamel differs from its natural prototype is in the introduction of human agency. Stones in the earth could not be engineered, but enamel could.

Returning to *The Deep Dyeing of Stones*, the recipe for enameling, though short, also recounts how to manipulate color through the extension of heat. The recipe itself, if followed to the letter, will result in green glass. However, if heat is applied longer, the glass will turn "golden," or, more likely, yellow. If heated even longer than that, the glass

[30] Aristotle, *Meteorology*, Bk 4, 383a.

will turn white. Both color changes to yellow and white are due to the presence of tin in the glass, and so the directions to extend the heat do not, at first glance, seem all that significant.[31] Yet they present an option for the enameller to intervene into what is essentially a process that analogizes nature. Through the will of the enameller, the outcome of the process can straightforwardly imitate nature and result in a green stone, or, through human will, the stone can be changed from green to yellow to white. The distinction is important, because as Byzantine enamellers grew more confident, they departed from straightforward imitations of natural processes and began to showcase the artificiality of the material they created.

Enamel, Gemstones, and Material Mimesis

In Chapter 6 of *On the Most Noble and Renowned Goldsmith's Art*, one of the artistic treatises included in the alchemical corpus describes how to make enamel.[32]

> Explanation of Enamel – Grind the enamel finely on the grinding stone and set it in a shell. Wash it thoroughly. Then set it [i.e., the enamel] into the design. Place it into the furnace-fire, setting the niello also in the furnace. The furnace should be [made of] iron sheet-metal with a domed chamber and punched through with perforations. Bring [the bellows] and work it until you see the silver flow with the lead on the wood-[fire]. Set it into the furnace-fire again until the enamel quickens a second time.[33]

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[31] On tin in the creation of yellow and white enamel, see Biron, *Émaux sur métal*, 156.

[32] For a discussion of *On the Most Noble and Renowned Goldsmith's Art*, see Chapter 1.

[33] ΕΡΜΗΝΕΙΑ ΤΟΥ ΣΜΑΡΔΟΥ. —Τρίψον λεπτὰ τὸν σμάρδον ἐν τῇ ἀκμώνῃ, καὶ θὲς εἰς κογχύλην· καὶ πλύνον καλῶς. Εἶτα βάλε ἐν τῷ γλύμματι· θὲς αὐτὸ ἐν τῇ πύρᾳ ἐν φουρνελλίῳ σιδηροῦν καθὼς καὶ τὴν ἔγκοψιν ἐν φουρνελλίῳ· ἔστω δὲ τὸ φουρνέλλιον σιδηροῦν πέταλον καμαροειδῶς καὶ κοσκινοειδῶς τετρημένον· καὶ ἔνεγκον αὐτὸ, τρίψον,

The recipe is straightforward. The glass fill is ground and laid into the *cloison* design. The enamel is fired together with niello to gauge the temperature of the fire. The silver and lead of the niello will melt and fuse first, indicating how much longer the enamel must be fired. A perforated iron dome covers the niello and enamel to prevent ashes and soot from falling into and corrupting them. The author concluds the recipe by directing the reader to fire the enamel again, as glass fill must be reapplied and built up to the level of the *cloison* wires.

The title of the recipe warrants closer inspection. The word used for enamel in this recipe is not *chymeutos* or a variant, but σμάρδος (*smardos*), the Hellenization of the Italian word *smalto*, meaning "enamel."[34] The presence of an Italian word in the recipe is not altogether strange. The recipe appears in Paris gr. 2327, which was copied in 1478 on Crete. The copyist, Theodore Pelekanos, frequently updated older texts by supplying vocabulary used in the current Cretan dialect, heavily inflected by Venetian presence on Crete.[35] Curiously, however, Pelekanos appended his own title, carefully adding two Greek letters, αγ, above the word σμάρδος in the manuscript to create σμάραγδος (*smaragdos*, "green stone"), the Greek word for emeralds and other green gems. Thus, Pelekanos elided enamel with the creation of imitation gemstones and resituated the recipe within a Byzantine system of classification already seen in *The Deep Dyeing of Stones.*

ὥστε ἴδῃς τὸν ἄσημον μεσμιρεῖν μετὰ μολίβδου ἐν ξύλῳ. Καὶ πάλιν θὲς ἐν τῇ πύρᾳ εἰς τὸ φουρνελλίῳ, να κινήσῃ δεύτερον ὁ σμάρδος. For a full translation and commentary, see Appendix I.A.

[34] See Appendix I.A, n2.

[35] See Appendix I.A. n2.

Nikodim Kondakov, writing in the late nineteenth century, was the first modern scholar to explore the relationship between Byzantine enameling and the manufacture of imitation precious stones, as well as the first to link both enamel and artificial gemstones to the evidence from the alchemical corpus.[36] He hesitated, however, to embrace fully the position that enamel imitated gemstones. To Kondakov, the possibility that enamel was a merely imitative substance seemed reductive. Although he conceded that enamel had some relationship to artificial replication, he preferred to connect enameling to painting in order to elevate it within a nineteenth-century hierarchy of media.[37] In Kondakov's historical moment, enamel was categorized as a "minor" art, and to suggest that it was merely an imitation of true natural precious stones would have diminished its standing further. In his reluctance to examine the ways in which Byzantine enamel was made and employed with artificial replication in mind, Kondakov neglected a critical aspect of how Byzantine makers and users defined enamel.

Yet enamel's material mimesis of gemstones must be taking seriously. As we

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[36] Nikodim Pavolvich Kondakov, *Geschichte und Denkmäler des byzantinischen Emails* (Frankfurt: August Osterreith, 1892).

[37] This is one of the very first arguments that Kondakov sets forth in his monograph. Regarding the origins of medieval enameling, his argument was in dialogue with the work of Jules Labarte. Labarte contended that enamel, especially enamel that he described as "encrusted" over an entire object (that is, full enamel), was made as an imitation of precious stones and later took on pictorial dimensions. Kondakov vehemently denounced this assessment, and claimed that while gemstones could be inlaid, enamel had a pictorial dimension from its very beginnings and should thus be considered a graphic art rather than a mere material. Kondakov, *Geschichte und Denkmäler des byzantinischen Emails,* 2–14.

have seen, Byzantine notions of the artificial were more nuanced than modern scholarship has assumed. In Byzantium, artificial materials were embraced for their utility and their beauty. Byzantine artisans employed enamel in much the same way that they employed gemstones. The Byzantine preference for translucent red, green, and blue enamels early in enamel production recalls the arrangement of garnets, emeralds, and sapphires on objects such as the diadem ornament in Athens. They framed enamels with pearls to draw attention to their color and luminosity. Eventually, Byzantine artisans began pairing enamel with natural precious stones in the same object, inviting comparison between the natural and the artificial. These modes for drawing attention to how enamel resembled gems also threw into stark contrast the ways in which enamel was *not* like stones, most notably its capacity for graphic representation. I posit that enamel's imitation of gemstones functions as a clever foil against which viewers can clearly perceive human intervention at work.

Enamel's resemblance to precious stones is well illustrated by a pair of magnificent tenth-century περικάρπια (*perikarpia*, "wrist-cuffs") made of gold, which were excavated in 1956 in Thessaloniki as part of a larger hoard (Fig. 39).[38] Each cuff is

[38] The hoard, found in the course of infrastructure construction and maintenance on Dodekanisou Street toward the east of the Thessaloniki city center, also consisted of several pairs of gold earrings, a pectoral cross, an amulet made of white stone, buttons, and Turkish, Austrian, and Venetian coins dated to the seventeenth century. Despite the numismatic evidence, scholars have consistently dated the cuffs to the late ninth to early tenth century based on technique and materials. See Stylianos Pelekanidēs, "Τα χρυσά βυζαντινά νομίσματα της Θεσσαλονίκης," *Deltion of the Christian Archaeological Society* 1 (1960): 55–71; Helen C. Evans and William D. Wixom, *The Glory of Byzantium: Art and Culture of the Middle Byzantine Era, A.D. 843-1261* (New York:

composed of two convex gold sheets cut in a tapered pattern intended to flare outward at mid-forearm and narrow at the wrist. The two sheets are joined at one side with a hinge and a chain and pin closure at the other. Twenty rectangular full enamel *cloisonné* plaques, each measuring less than two centimeters square, cover the surface of each cuff. The design on each of the forty plaques is unique.[39] The plaques feature delicate renderings of three motifs: upright birds amidst foliage, carrying teardrop-shaped objects, likely grapes, in their beaks; rosettes; and a stylized floral-vegetal motif known as an ανθέμιον (*anthemion*, "flower"). The enamels on the Thessaloniki *perikarpia* are no longer in their original order, a consequence of their restoration shortly after discovery, but their intended effect remains.[40]

The background of the plaques is a bright, vivid green that absorbs and refracts light dynamically (Fig. 40). The color of the background is reminiscent of any number of precious green stones, from emeralds to peridot to jade depending on the play of light across its surface. Although now cracked, the enamel would originally have been smooth and faultless, its clarity uninterrupted by natural inclusions or structural crystals. Rich ruby red and deep sapphire blue function as accent colors, and they too are clear and

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Metropolitan Museum of Art, 1997), 243; Bosselmann-Ruickbie, *Byzantinischer Schmuck,* 274–79.

[39] The enamels vary slightly in size from 1.5 x 2.2 cm, but overall maintain a remarkable uniformity. Bosselmann-Ruickbie, *Byzantinischer Schmuck*, 274.

[40] Bosselmann-Ruickbie notes that the enamels on the lower register of the cuffs do not appear to be in their original order. The bottom of the cuffs suffered significant damage and corrosion during burial, and the rearrangement of the enamels was likely a result of undocumented restoration shortly after their discovery in 1956. Bosselmann-Ruickbie, *Byzantinischer Schmuck,* 274.

unblemished. For variety, the enameller included various opaque colors, including a soft pale blue, white, and turquoise. The blue is not fully opaque but semi-opaque, giving it a milky quality similar to stones such as chalcedony and moonstone. The white enamel has sometimes been left to swell gently over the *cloison* wire, as if it were fashioned from spherical pearls. The turquoise, which suffered the most damage from burial, is now pitted and cracked, but in its original state it would have been bright and vibrant like its natural model. All of the colors of the Thessaloniki *perikarpia* recall precious stones in hue, luminosity, and luster. The parallels are so consistent that these artistic choices must have been deliberate.

Moreover, the enamels on the *perikarpia* are attached to the structure of the cuffs using heavy bezels. A bezel is any metal frame that secures a stone to an object, and the wire can be as thin or as thick as the artisan desires. A heavy bezel is made from thick gauge wire and increases the amount of light reflected around the stone, enhancing its luminosity (for example, see Fig. 37). The heavy bezel may seem like a technical feature that has no semantic dimensions, but in Byzantine jewelry design, heavy bezels were often used to set precious stones. As a result, they came to signify the presence of precious stones. For example, in the mosaic of Emperor Justinian discussed in Chapter 2, a red border surrounds the central scene (see Fig. 26). On this border are represented round and rectangular precious stones, which are only recognizable as such because of the gold rim around each stone that indicates a heavy bezel mount. In the Thessaloniki *perikarpia*, the choice to use heavy bezels may be significant. The enamels could have been attached in any number of ways, and on other objects enamels are often set with rivets or prongs. But the artisan who made the *perikarpia* selected a framing device that

signaled the presence of gems, encouraging a viewer to equate the enamels with precious stones.

Enamel could also be positioned in relationship to natural stone by setting them side-by-side. A ninth- or tenth-century pectoral triptych once housed in the Georgian monastery of Martvili and now in the State Museum of Fine Arts in Tbilisi is an early example of accentuating enamel with pearls and gems (Fig. 41). The structure of the triptych is composed from gilded silver, with angels represented in repoussé on its doors. Now badly damaged, the central enamel once depicted the scene known as a δέησις (*deēsis*, "supplication"), in which the Virgin Mary and John the Baptist entreat Christ for mercy upon humanity. The central figure of Christ, perhaps once also rendered in repoussé, is now missing. Like the *perikarpia*, the enamel of the Martvili triptych employs deep jewel tones, including the same emerald green background. The Virgin's robes and John the Baptist's hair shirt are translucent blue. The enameller chose a wider range of opaque colors, including red, blue, yellow, flesh tones, and white. Vine-like tendrils curl behind the figures and bloom with teardrop-shaped blossoms, perhaps evoking the garden of paradise. Around the border of the triptych are alternating garnets, emeralds, and pearls in oval, square, and round shapes. The presence of rings around the enamel suggests the vignette of the *deēsis* was framed with more pearls. Even the pin of the triptych's pendant hinge features an emerald.

There is a powerful material interplay at work on the Martvili triptych, in particular when the it is closed. The exterior of the doors is not enameled. When the triptych is closed, the enamel is concealed, and only the earthly stones are visible. They are shaped and set but not otherwise altered from their natural state. When the triptych is

opened, the enameled *deēsis* is revealed showing all the splendor of heaven. The scene of the *deēsis* exposes the limits of the natural stone; although they can be carved or cut and inlaid, the natural stones cannot achieve the same level of representation as the enamel. Insofar as representation is concerned, the artificial material far surpasses its natural counterpart. Enamel is able to imitate the color and luminescence of gemstones, but stones cannot imitate enamel. Nature can be replicated, but the artificial transcends its model and testifies to the power of human ingenuity.

This power dynamic is also visualized in some of the earliest Byzantine enamels, a pair of medallions representing the Virgin Mary and Saint Theodore now incorporated into the Khakhuli Triptych in Tbilisi and dated to the ninth or tenth century (Fig. 42). While the linework of the enamels is clumsy and conveys only basic iconography, the colors are a rich and vibrant assortment of translucent and opaque jewel tones. Around the border of the medallions the glass is a deep blue, dotted with circles in opaque white and a softer light blue. The circles on the medallions approximate pearls, an almost playful gesture on the part of the enameller to signify that any addition of natural pearls would be superfluous; the enameller had the ability to generate a pearl frame all on his own.

By the early tenth century, as seen in the votive crown of Leo VI, now the treasury of San Marco (Venice), enamellers began to experiment with color and improved draftsmanship (Fig. 43). Named for emperor Leo VI (r. 886 – 912), who is pictured in an enameled roundel, the crown has been repurposed and restored.[41] Though

[41] The votive crown is now incorporated into a Western medieval object known as the Grotto of the Virgin. It was heavily restored in the nineteenth century. On the repurposing

they have been rearranged and some are now missing, the enamels are original.[42] Like gemstones, the enamels are set in circular heavy bezels and framed with pearls and garnets. Two of the most notable features of the enamels on the crown are their more prominent use of opaque colors and smooth regularity of line. In place of the restricted palette of translucent blues, greens, and reds and a limited amount of opaque blue, white, red, and yellow seen in the *perikarpia* and the Martvili triptych, the enamels of the Leo crown explode with color. The saints pictured on the crown wear shades of fully opaque light blue, bright aqua, turquoise, and even lavender. The emperor himself wears a deep purple robe and a yellow a λῶρος (*lōros*; an item of imperial regalia in the form of a long stole [scarf] studded with pearls and precious stones that was worn around the shoulders and crossed in front of the body). Translucent jewel-like colors in the crown's enamels have been relegated to the background and used as accents. At the same time, the figures themselves are articulated clearly, with their features illustrated in proportion, a departure from the rudimentary linework seen on the Tbilisi medallions (see Fig. 42). The enamels of the Leo crown differ from the other examples considered here in that they do *not* fully mimic natural stones. Instead, the enameller embraced artificiality, showcasing human interventions and human control over materials. This new emphasis on artifice rather than mimesis marks a shift in Byzantine enameling from imitation to innovation, and highlights not just knowledge of nature, but also power over it.

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of the crown and its nineteenth-century history, see Stefania Gerevini, "The Grotto of the Virgin in San Marco: Artistic Reuse and Cultural Identity in Medieval Venice," *Gesta* 53, no. 2 (2014): 197–220.

[42] Gerevini, "The Grotto of the Virgin," 200.

The Power of Artifice: Vessels from the Treasury of San Marco

The Treasury of San Marco in Venice is home to one of the most impressive collections of Byzantine enamels in the world. Icons, medallions, and reliquaries made from enamel abound within its walls, but perhaps most impressive is the Treasury's collection of mixed-media vessels. Like the paten discussed in the introduction to this chapter, these vessels are composed from natural stones. Enamel – in the form of frames, bases and roundels – decorates the natural stone vessels. On these vessels, the natural stone is in constant dialogue with enamel, its artificial imitation. In some cases, the enamel might be argued even to upstage the natural stone, for example, when it is employed to encase and uphold the natural stone, or when an enameled element draws attention away from the natural stone. I argue that this relationship between natural and artificial on the San Marco vessels is not neutral; rather, the artificial claims power over nature.

A tenth-century chalice in the San Marco Treasury bears a dedicatory inscription naming an emperor Romanos (Fig. 44). Although the chalice is usually assigned to the reign of Romanos II (r. 945 – 963), Romanos was a popular name, and was used by no less than four emperors between the tenth and eleventh centuries.[43] The chalice has thus borne the indistinct name, "The Chalice of the Emperor Romanos," sometimes designated "without handles" to differentiate it from another chalice in the treasury with Romanos named in the inscription.[44] The bowl of the chalice is fashioned from brownish-

[43] The other emperors are Romanos I (r. 920 – 944), Romanos III Argyros (r. 1028 – 1034), and Romanos IV Diogenes (r. 1067 – 1071).

[44] David Buckton, ed., *The Treasury of San Marco Venice* (Milan: Olivetti, 1984), 137.

purple sardonyx, interrupted at random intervals by clouds of milky-white inclusions. The sardonyx bowl is beautifully carved in a lobe and dart pattern, and at its center lies an eight-petaled rosette. Scholars date the bowl to the third or fourth century based on comparanda from late antiquity.[45] The base of the chalice is formed of gilded silver adorned with three enameled roundels in scalloped frames, depicting Saint Cosmas, the Archangel Gabriel, and the Annunciation to the Virgin. The inclusion of the Annunciation of the Virgin, which has been cut down, suggests that the enamels on the base of the chalice were added later, perhaps in the large-scale restoration project in the Treasury in the late nineteenth century.[46] Around the top of the chalice is an elegant armature of gilded silver in which are mounted fifteen rectangular sunk enamel plaques, which depict Christ, John the Baptist, Saint Peter, Saint Matthew, Saint Mark, Saint Luke, Saint Gregory Nazianzus, Saint Basil, the Archangel Gabriel, the Virgin Mary, the Archangel Michael, Saint Nicholas, Saint John Chrysostom, Saint John the Evangelist, and Saint Paul.[47] At the base of the armature are rings with the remnants of wires that may have once suspended precious stones.

Scholars have noted the excellent quality of both the sardonyx bowl and the enamels, but they have not examined the relationship between these two components in

[45] Buckton, *The Treasury of San Marco*, 137-39

[46] Buckton, *The Treasury of San Marco*, 139.

[47] It has been suggested that the enamels are not in their original order. See Buckton, *The Treasury of San Marco,* 139.

detail.[48] That the bowl of the chalice and its frame should be considered together is indicated in the formal echoes between them. The carved darts of the sardonyx bowl each point to a holy figure, and the ribbed lobe pattern of the bowl mirrors the separation of each enameled plaque from another by a string of pearls. As this chapter has shown, there is also a material relationship between the bowl and its enameled frame. As artificial "stones," the enamels that frame the chalice are ostensibly fashioned from the same material, but their appearance and placement on the chalice indicate a level of superiority.

As on the Stoclet Paten, the enamels of the chalice announce their artificiality through their perfection. The glass of the enamels is clear and unblemished in comparison to the cloudy sardonyx. The sunk enamel technique differentiates the enamels even further from stones, though their rich jewel-toned robes still evince the hues and radiance of gems. There is no attempt to communicate material similarity between the bowl of the chalice and its frame, even if their processes of generation were understood to be the same. The tangible difference between the enamels of the frame and the bowl of the chalice is not simply chance, but can be read as an intentional artistic choice to separate the natural from the artificial, the earthly from the heavenly, and, given the ancient origins of the sardonyx bowl, perhaps even the pagan from the Christian. It is no coincidence that the enamels frame and encase the natural stone. This encasement restricts the experience of the natural sardonyx on its own and demands it be read materially through its relationship with the enamels. As Glenn Peers has shown,

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[48] For an example of a study that does not address the relationship between media used for the chalice, see H. R. Hahnloser, ed., *Il Tesoro di San Marco*, vol. II, *Il Tesoro e Il Museo* (Florence: Sansone Editore, 1971), 47.

Byzantine viewers were sensitive to the mediating role that frames played, using framing devices to insist upon a sense of presence in their art.[49] On the Romanos chalice, the perfection of the artificial material, enamel, amplifies the presence of the sacred figures depicted by throwing them into stark relief from the organic, earthly imperfection of the sardonyx bowl. Even carved and carefully crafted, the sardonyx bowl cannot match the purity of color and sharpness of form in the enamels that surround it.

An even greater level of artifice is apparent in the so-called Chalice of the Patriarchs, another tenth-century sardonyx chalice in the Treasury of San Marco (Fig. 45). On this chalice, four enamel roundels are situated on straps that secure the bowl to its base. In the roundels are portrayed the martyrs Demetrios, Prokopios, Theodore, and Akyndinus. The foot of the chalice is composed of four trapezoidal enamel plaques representing the patriarchs who give the chalice its name: Gregory Nazianzus, John Chrysostom, Ignatius of Constantinople, and Theophylactos of Nicomedia. The *champlevé* inscription running around the rim of the bowl announces "Drink all of this, this is my blood, that of the New Testament that was shed for you and for many for the remission of sin" (Matthew 26:28), a phrase that is spoken during the celebration of the eucharist in the Orthodox liturgy. Along the rim of the foot and on the straps of the chalice are rosette and palm motifs.

On the Chalice of the Patriarchs, the sardonyx bowl is only carved insofar as is necessary for its function as a bowl. It has no lobes or darts, its only adornment is the series of pale striations that wind through the stone. The beauty of the stone is its natural

[49] Glenn Peers, *Sacred Shock: Framing Visual Experience in Byzantium* (University Park: The Pennsylvania State University Press, 2004), esp. 133.

hue and luster, which starkly contrasts to the multicolored enamels that surround it. The enamels on the Chalice of the Patriarchs are arresting in that they are entirely opaque. No translucent hues remind the viewer of enamel's beginnings as an imitation stone. The enamel is employed almost like painting, flat and dimensionless save for its polished sheen. The artisan of the chalice of the Patriarchs has fully embraced the artifice of enamel, pushing it beyond its inherent resemblance to gemstones and turning it into a full mode of graphic representation. The rosettes and palms gesture towards nature, but, like the sardonyx bowl which is confined and strapped down, the natural imagery on the enamels has been controlled, and abstracted into pure ornament.

Conclusion

In Byzantine traditions of alchemy and natural philosophy, artificial replications of natural materials were conceived of as different, but equal in value to the "real" thing. In natural philosophy inherited from Classical antiquity, artificial materials were equivalent to their natural prototypes because the processes to create them were the same. From an epistemological perspective, artificial replications were useful because they could elucidate and demonstrate knowledge of the functions of natural processes. In material culture, attitudes towards artificial materials were pragmatic. Artificial imitations of precious stones, such as glass, could be used to enhance the properties of natural stone. Conversely, artificial materials were appreciated for how they diverged from their natural prototypes, as in the example of a glass bead with greater clarity and luminosity than the natural stones around it.

In Byzantine scientific typologies, enamel was classified as an imitation gemstone. It received that classification because enameling mirrored theories of how stones were generated in the earth. These theories, drawn primarily from Plato, Aristotle, and Theophrastus, explained that stones were compounds of earth and water, liquified by heat and solidified through cooling. Enamel was composed of glass, which was also understood as earth, combined with water and fired until it liquified and then solidified as it cooled. The key difference between enameling and straightforward imitation was that enamel could be manipulated according to human will.

Middle Byzantine works of art evince the ways in which enamel was understood to imitate precious stone. Through jewel-toned color and through framing strategies such as heavy bezels, Byzantine artisans signaled enamel's close relationship to gems. Over time, however, rather than illusionistically imitating natural materials, Byzantine enamellers began to amplify and exhibit their artifice. The expansion of enamel's color palette and a closer attention paid to linework and draftsmanship revealed and even celebrated the human hands at work.

In mixed-media works such as the vessels of the Treasury of San Marco in Venice, enamel was paired with natural stone, including sardonyx and alabaster. In these combinations, enamel is used to represent Christ and the saints, and is employed either as frames or as central focal points. In each case, the enamel quite literally dominates the natural stone, making a statement about the power of both humankind and heaven over the natural world.

Chapter Four

The Virtuosity of Byzantine Enamel

As an alchemical technology of artificial replication, enamel reproduced powerful phenomena found in nature. Byzantine artisans arranged the products of these alchemical processes into figural and ornamental designs, demonstrating control over the natural world. This visual and material manifestation of dominance becomes all the more striking when the enameled designs increase in complexity, when scale is reduced or enlarged, and when line and color draw forth dynamic expression from glass and metal. Byzantine artisans were not content simply to make enamel; enamel was also made with intentional excellence. One of the most pervasive features of Byzantine enamel is its exhibition of a remarkable level of skill, a quality that scholars have commented on at length. At the end of the nineteenth century, Nikodim Kondakov praised the unusual diversity of color found in Byzantine enamels.[1] In the early twentieth century, O. M. Dalton noted that they display "complete mastery of technique and perfect consciousness of limitations."[2] In the mid-twentieth century, Klaus Wessel observed the "fineness of the drawing and quality of the workmanship" in Byzantine enamels.[3] In these ways, Byzantine enamel conforms to a characteristic of Byzantine art that James Trilling has called "conspicuous

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[1] Nikodim Pavlovič Kondakov, *Geschichte und Denkmäler des byzantinischen Emails* (Frankfurt: August Osterreith, 1892), 94.

[2] O. M. Dalton, "Byzantine Enamels in Mr. Pierpont Morgan's Collection," *The Burlington Magazine for Connoisseurs* 21, no. 112 (1912): 219–25.

[3] Klaus Wessel, *Byzantine Enamels from the 5th to the 13th Century* (Greenwich, CT: The New York Graphic Society, 1968), 127.

virtuosity," a "term for extraordinary skill; it is highly inclusive and already has connotations of display and performance."[4] I argue that the exquisite craftsmanship of Byzantine enamel was not merely a manifestation of ability, but rather a calculated articulation of technological power.

In this chapter I employ Trilling's concept to investigate the conspicuous virtuosity of Byzantine enamel: how it was cultivated, the forms it took in extant enameled objects, and the Byzantine cultural values that it embodied. I examine the tendency for Byzantine artisans to increase the technical difficulty of enameling without necessity, and I argue that this was done as a deliberate communication of mastery over the physical and mechanical limits of material and process. Given that material and process in enameling were demonstrative of knowledge and control of the natural world, the introduction of conspicuous virtuosity was a way to reify knowledge and control into forms to be admired. I explore the relationship between virtuosity, power, and the Byzantine concept of τάξις (*taxis*, "order"), and I contend that the astonishing skill seen in Byzantine enameling represented successful attempts to bring the chaos of matter into balanced, harmonious order.

The chapter begins by reviewing Trilling's concept of conspicuous virtuosity and its relationship to technology, nature, and power. First introduced in Trilling's seminal study of art and technology at the Byzantine imperial court, conspicuous virtuosity addresses how skillfully crafted artworks convey power, particularly the power of human

[4] James Trilling, "Daedalus and the Nightingale: Art and Technology in the Myth of the Byzantine Court," in *Byzantine Court Culture from 829-1204*, ed. Henry Maguire (Washington D.C.: Dumbarton Oaks Research Library and Collection, 1997), 225.

beings to shape and arrange their surrounding environment.[5] Virtuosity is defined as the power to control materials and their processing to the degree that both seemingly achieve the impossible, eliciting wonder and awe in viewers.[6] Trilling coined the term to examine the fascination with automata (moving mechanical sculptures and devices) at the Byzantine court. I propose that conspicuous virtuosity can also account for the refined craftsmanship and technical superiority of Byzantine enamel. I identify the features of virtuosity in Byzantine enamel, such as scale, rhythm and line, pattern and variation, and finally, Byzantine patrons' and artisans' firm preference for *cloisonné* above other, less difficult methods of enameling.

The chapter proceeds by assessing each of these features in order, starting with scale. Byzantine enamellers pushed size to its limits, producing enamels at either extreme of an impressive range – as small as fingernails or as large as dinner plates – but rarely any of moderate size. Making enamel either very large or very small necessitates addressing particular challenges, such as fitting the design into the allotted space or confronting issues of physics that constrain the expansion and cooling of glass and metals. That Byzantine artisans were able to produce enamels of such extreme sizes speaks to their keen awareness of the physical possibilities of materials and their confidence in handling those challenges. Size likewise has an impact on viewers, who must look closely at small enamels to appreciate their minute design and for whom large enamels would have left an overwhelming impression. At either end of the scale spectrum, enamel intentionally amazes.

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[5] Trilling, "Daedalus and the Nightingale," 224-25.

[6] James Trilling, *The Language of Ornament* (New York: Thames & Hudson, 2001), 174.

I then examine how, within the confines or expanse of an enameled work, Byzantine artisans demonstrated considerable skill in drawing and the arrangement of form into patterns. The enameled design is linear and graphic by the very nature of the *cloisonné* technique, which is composed of a network of individual cells defined by thin strips of metal. However, there are no technical parameters for *cloisonné* linework beyond the construction of a cell, and the lines may be as crude or refined as the artist's ability allows. On the whole, Byzantine enamels display exceptionally fine linework, often juxtaposing soft curves with sharp angles to achieve expression and movement in both figural and ornamental representation. Forms are rendered with utmost precision, to the point that some enamels assume an appearance of having been made by machine rather than by hand. The use of repeating forms, such as chevrons and hearts, and alternating colors and levels of translucency creates a sense of visual rhythm, balance, and variation in accordance with a Byzantine aesthetic that privileged both variety and orderly array.

One aspect of Byzantine enamel that is perhaps most connected to its virtuosity is the persistent commitment to the *cloisonné* technique despite its inherent difficulty. *Cloisonné* is more laborious and fastidious than other forms of enameling popular in the Middle Ages, such as the *champlevé* technique favored in the medieval West. In *cloisonné*, there is a higher margin for error, and the demand for knowledge of a wide range of goldsmithing techniques, such as wire-making, forming, and soldering, which are unnecessary in other methods of enamel production. I posit, however, that *cloisonné* appealed to an overarching and fundamental Byzantine social value, that of *taxis* (order). The placement of glass into a space confined by the borders of golden wire, arranged by

color, and defined by shape, was analogous to the larger Byzantine preoccupation with organizing the world into carefully controlled systems – whether the hierarchy of the Byzantine court or the rankings of categories of saints.[7] As such, part of the alchemical project of making enamel was taking the very matter that constituted the physical world and bringing it into a systematic arrangement that reflected Byzantine cultural attitudes towards the ideal structure of both earth and heaven.

The chapter ends with an analysis of what is perhaps the most ambitious work of Byzantine enamel to survive, the icon of the archangel Michael now in the Treasury of San Marco in Venice. In this work, enamel is employed in three dimensions with *cloisonné* fashioned in relief to compose the archangel's face and body, an astonishing technical feat. The archangel stands at the ready, with sword and orb in hand. On and around him, the fields of representation organize into pure pattern, indicative of both earthly and heavenly perfection. Ultimately, I interpret the enameled icon as a statement of total technological power exerted over the material world.

"Conspicuous Virtuosity" in Byzantine Enamel

James Trilling coined the term "conspicuous virtuosity" to reframe the arguments of anthropologist Mary W. Helms.[8] In her book *Craft and the Kingly Ideal: Art, Trade, and*

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[7] On *taxis* in art, see Henry Maguire, "The Cycle of Images in the Church," in *Heaven on Earth: Art and the Church in Byzantium*, ed. Linda Safran (University Park: The Pennsylvania State University Press, 1998), 121-51; Eunice Dauterman Maguire and Henry Maguire, *Other Icons: Art and Power in Byzantine Secular Culture* (Princeton: Princeton University Press, 2007), 135-56.

[8] Trilling, "Daedalus and the Nightingale," 225.

Power, Helms connects power and authority with what she called "skilled crafting."[9] Trilling, by contrast, chose "virtuosity" to designate extraordinary levels of skill, and "conspicuous" to stress the intentional display of such skill.[10] According to Trilling, extraordinary skill in Byzantium was linked to the imitation of nature, which (as detailed in Chapter Three) was a crucial aspect of making enamel. Yet the imitation of nature seen in enameling was not illusionistic. Rather it was an imitation of nature's mechanics. Mechanical imitation of nature, as Trilling states, is not undertaken for the purpose of aesthetic pleasure alone. It is also a targeted assertion of power:

> Whereas the artistic imitation of nature is primarily a statement about art, the mechanical imitation of nature is in some degree a statement about nature. It implies that nature operates mechanically and thus can be explored, described, and at least symbolically claimed or mastered mechanically.[11]

Trilling's observations about the mechanical imitation of nature are literal, given that the topic of his study is Byzantine automata. He is careful, however, to note that the triangulation of nature, virtuosity, and power extended to other categories of Byzantine art as well.[12] Trilling expanded his notion of virtuosity over time, explaining that

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[9] Mary W. Helms, *Craft and the Kingly Ideal: Art, Trade, and Power* (Austin: University of Texas Press, 1993).

[10] Trilling, "Daedalus and the Nightingale," 225.

[11] Trilling, "Daedalus and the Nightingale," 224.

[12] He cites, for example, the arrangement of marbles on the floor and walls of Hagia Sophia, and the Byzantine affinity for semi-precious stone vessels as prime examples of conspicuous virtuosity, see Trilling, "Daedalus and the Nightingale," 227.

virtuosity's power dynamic in relationship to nature lies in the artisan's ability to accentuate or push the physical limits of the properties of a given material.[13] Virtuosity is an articulation of human will over the circumscribed natural behaviors of matter. As Trilling notes, "virtuosity denies the power of materials and thus, in a sense, reality."[14] Virtuosity, then, is a means of working material with the ideal rather than the real in mind, and as such makes a statement about the ability of human beings to control and master their lived environments. Virtuosity is a material language of power, conspicuous in its purposeful visualization of extraordinary skill.

Such virtuosity is exemplified by one of the best preserved Byzantine enameled objects, the tenth-century Limburg σταυροθήκη (*staurothēkē*, literally "cross container," a container for a relic of the True Cross on which Christ was crucified) (Fig. 46). This magnificent reliquary of the True Cross is one of the finest examples of imperially sponsored devotional objects produced in Byzantium. A composite object formed of multiple parts, the gold-clad cross in the reliquary's interior was commissioned by the emperors Constantine VII Porphyrogennetos (r. 913 – 959) and his son, Romanos II (r. 945 – 963), who are both named in an inscription on the reverse of the cross (Fig. 47).[15]

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[13] Trilling, *The Language of Ornament*, 174.

[14] Trilling, *The Language of Ornament*, 182.

[15] On the inscriptions of the *staurothēkē*, see Brad Hostetler, "The Limburg Staurotheke: A Reassessment," *Athanor* 30 (2012): 7–13; Andreas Rhoby, *Byzantinische Epigramme auf Ikonen und Objekten der Kleinkunst*, Byzantinische Epigramme in Inschriftlicher Überlieferung 2 (Vienna: Verlag der Österreichischen Akademie der Wissenschaften, 2010), 163–69; Anatole Frowlow, *La relique de la vraie croix: recherches sur le developpement d'un culte*, Archives de l'Orient Chrétien 7 (Paris: Institut français d'études byzantines, 1961), 233–37.

This first phase of the *staurothēkē*'s construction can be dated to 945 – 959, the period of the emperors' co-reign. The second phase of the *staurothēkē*'s construction was the commission of the *thēkē* (container) proper by the well-known court eunuch Basil the πρόεδρος (*proedros,* a title of high rank, just below imperial status). Basil the *proedros* was the illegitimate son of emperor Romanos I (r. 920 – 944), who was Constantine VII's father-in-law and regent, and therefore Romanos II's grandfather.[16] A dedicatory inscription naming Basil wraps around all four sides of the *thēkē*, and the mention of his title as *proedros* places the date of the *thēkē* sometime between 963, when emperor Nikephoros II Phokas (r. 963 – 969) bestowed the dignity upon Basil, and 985, the year of Basil's death.[17] The *thēkē* is a large rectangular case (48 x 35 x 6 cm) backed with gilded silver. Its interior is fashioned from *cloisonné* enamel on gold in the form of small compartments with doors used to house relics of Christ, John the Baptist, and the Virgin

[16] Marvin C. Ross, "Basil the Proedros Patron of the Arts," *Archaeology* 11 (1958): 271–75; Bissera Pentcheva, "Containers of Power: Eunuchs and Reliquaries in Byzantium," *Res. Journal of Anthropology and Aesthetics* 51 (2007): 109-20.

[17] On the dating of the *thēkē* see Nancy Ševčenko, "The Limburg Staurothek and Its Relics," in *Θυμιαμα στη Μνήμη της Λασκαρίνας Μπούρα* (Athens: Benaki Museum, 1994), 289–94. On the dedicatory inscription on the *thēkē*, which has been the subject of much scholarly debate, see Enrica Follieri, "L'ordine dei versi in alcuni epigrammi bizantini," *Byzantion* 34 (1964): 447-67; Johannes Koder, "Zu den Verinschriften der Limburger Staurothek," *Archiv für mittelrheinische Kirchengeschichte* 37 (1985): 11-31; Bissera Pentcheva, *The Sensual Icon: Space, Ritual, and the Senses in Byzantium* (University Park: Pennsylvania State University Press, 2010), 160-70.

Mary.[18] The sliding lid of the *thēkē* is an astounding composition of *cloisonné* enamel, pearls, and precious stones.[19]

While studies of the *staurothēkē*'s inscriptions and relics are many, the enamels have received comparatively little scholarly attention. Yet they are among the most artistically accomplished of Byzantine production. Analyzing each of the enamels attached to the *staurothēkē* would be impractical, but the nine enamels in the central grid of the reliquary's lid are representative of the quality of the object as a whole (Fig. 48). The enamels of the central grid represent the regimented order of the heavenly court. At the center is Christ seated on an ornate throne made of gemstones, topped with vegetal finials and complete with a bejeweled footstool and elaborately decorated cushion. To either side of Christ are the Virgin Mary and John the Baptist together with the archangels Michael and Gabriel. The Virgin and John the Baptist hold out their hands to Christ in gestures of beseeching, so that the three central panels of the grid form an iconographical construct of intercession known as a δέησις (*deēsis*, "supplication"). Above and below the *deēsis* are two groups of six saints, including apostles and evangelists. They include (clockwise from top left): James, John the Theologian, Paul, Peter, Andreas, Mark, Simon, Philipp, Matthew, Luke, Thomas, and Bartholomew. This

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[18] For a detailed study of the relics of the Limburg staurotheke, see Ševčenko, "The Limburg Staurothek," 289-94; Holger A. Klein, *Byzanz, der Westen, und das 'wahre' Kreuz: Die Geschichte einer Reliquie und ihrer künstlerischen Fassung in Byzanz und im Abendland* (Wiesbaden: Reichert, 2004), 105-12.

[19] Several filigree plaques, gemstones, pearls, and enamels were replaced during the *staurothēkē*'s extensive restoration in the 1950s, see Johann Michael Wilm, "Die Wiederherstellung der Limburger Staurothek," *Das Münster* 8 (1955): 235–40.

grouping of saints and archangels depicts a divine hierarchy, where Christ holds the highest rank and saints and angels attend him. All nine plaques are executed in sunk enamel and framed with square-cut garnets, emeralds, and rock crystals. Full enameled plaques with a cross-shaped geometric pattern in blue, red, and white frame the grid and echo the larger geometric panels on the lid's outer-most edges.

The enamels in this central grid present the viewer with a plethora of colors, opacities, and shapes. The opaque blue of the saints' garments is especially arresting, with shades of turquoise, eggshell, and lapis alternating in a series of rounded stripes that serve to model drapery. By contrast, the three principal figures of Christ, the Virgin, and John the Baptist are robed in deep translucent blue and red, creating the impression of luminous, jewel-like fabric. The archangels wear the imperial ceremonial garment known as a λῶρος (*lōros*, a long, heavy stole studded with gems and pearls), indicated by the graphic cubic pattern that runs vertically down the length of their bodies and drapes over one arm.[20] The opacity of the archangel's dress is juxtaposed with their alternately translucent and opaque wing feathers, rendered in shades of blue, red, and green. The figures' faces are dainty, with almond-shaped eyes directed toward the center, drawing the viewer's gaze to the central figure of Christ enthroned. Christ's own gaze looks away, slightly past the viewer. The figures' mouths are alternately upturned and downturned

[20] In Byzantine art, archangels wear the *lōros* exclusively in the context of the heavenly court in order to indicate their secondary rank in relationship to Christ, a rank they share with the emperor on earth. The presence of angels in the *lōros* on the *staurothēkē* confirms that the scene on the lid takes place in a heavenly context. See Henry Maguire, "The Heavenly Court," in *Byzantine Court Culture from 829 to 1204*, ed. Henry Maguire (Washington, DC: Dumbarton Oaks Research Library and Collection, 1997), 247-58.

depending on whether the figure is or isn't bearded, giving the bearded saints and Christ an air of gravity and seniority, and lending the beardless figures a sense of youth and vitality. The ranks of holy figures are depicted with their standard attributes: the apostles hold scrolls in their hands while the evangelists and Saint Paul hold jeweled codices. The saints' long, elegant fingers gesture towards each other or towards the viewer. Remarkably, each saint is rendered individually, with slight variations in the color, translucency, and details of their dress; no figure is identical to another.

The lines of the *cloisons* are remarkably thin. On the central enamel of Christ, for example, visible lines trace the folds of his robe and crisscross to form a lozenge pattern on the white back of the throne (Fig. 49). In other instances, however, the *cloison* wire is so stretched as to be barely discernable to the naked eye, such as in the pearls that dot the throne or the yellow circles in the red ring of Christ's nimbus. The plaque depicting Christ enthroned demonstrates the differing shapes and forms that compete with one another throughout the *staurothēkē*'s decoration. The rounded drape of his garment contrasts with the linear grid of the throne's lozenge pattern, and the horizontal thrust of the throne's cushion is juxtaposed with the verticality of the jeweled columns that form the throne's core structure. From a technical perspective, the enamels are as close to perfect as humanly possible, almost unbelievably so. No colors bleed out from the confines of their cells. The colored glass is uniform and unblemished by impurities. The linework of the *cloisons* is fluid and confident. The figures are simultaneously expressive and reserved, as befits the highest ranks of the heavenly hierarchy.

The *staurothēkē*'s enamels evince a painstakingly high level of craftsmanship. There can be no doubt as to the skill of the enamellers tasked with decorating the

reliquary. The overall effect of the enamels in the central grid is one of delicacy and intricacy. Yet, the complexity and amount of detail in the enamels is not necessary for their construction or even to convey the desired scene. On the contrary, the addition of each detail presented new technical challenges and increased the odds that the enameller would make an error. The tangible sophistication of the enamels on the Limburg *staurothēkē* turns the very skill of its makers into an aesthetic feature and invites viewers to wonder at how such an object could possibly be made.

The amazement elicited by enamels such as those of the Limburg *staurothēkē* recalls the power dynamics discussed in Chapter Two: making as a means of constructing and demonstrating knowledge. Those who know how an object is made take pleasure in sharing in the knowledge of its makers, while those who do not know wonder at the making. The purpose of conspicuous virtuosity, however, is to astound both groups with the *degree* of knowledge and, crucially, the *control* exhibited in the making process. Making is knowing, but making extraordinarily well is to exhibit the extent of that knowledge as a display of power. The reification of power in Byzantine enamel took several forms: the mastery of the physics engaged in the enameling process, which governed attributes such as scale; and mastery of materials, which determined the forms and colors used to render figural narrative or ornamental motifs. This power over physics and materials is, in effect, power over nature itself.

The Challenges of Scale

Scale is an aspect of Byzantine enamel that allows conspicuous virtuosity to come to the fore. In enameling, scale is determined by the physical demands of the materials used

(i.e., glass and metal) and the force applied (i.e., heat). The creation of either very small or very large enamels presents a series of challenges to the artisan that must be overcome. In small enamels, the restriction of space limits design possibilities. The graphic skills of the enameller are pitted against the material constraints of the process, so that the artisan must strike a balance between the desired representation and successful execution of the technique. In large enamels, the enameller must negotiate the differing rates of cooling and expansion exhibited by glass and metal; the larger the enamel, the greater the disparity of heating and cooling across the surface of the object and the higher the risk that the enamel will crack and fall apart. Byzantine enamellers confronted the challenges of scale with enthusiasm. They created elaborate designs in a reduced amount of space and pushed the boundaries of what is physically possible by enameling on great expanses of gold. In what follows, I consider examples of Byzantine enamel that flaunt their ability to push the technical parameters of enameling to the farthest limits.

The Dumbarton Oaks Collection is home to an enameled plaque representing the bust of St. Demetrios (Fig. 50).[21] The plaque is square and executed in sunk enamel on gold. The saint wears a patterned χλαμύς (*chlamys*, "cloak") and holds a martyr's cross as he peers out at the viewer. The drapery of his garment is indicated by chevron-shaped *cloisons* beneath his right shoulder, and his halo shines bright blue with a red exterior ring. The lines of the saint's body are smooth, with identifying details such as gentle

[21] Marvin C. Ross, *Jewelry, Enamels, and Art of the Migration Period*, ed. Stephen R. Zwirn and Susan A. Boyd, *Catalogue of the Byzantine and Early Mediaeval Antiquities in the Dumbarton Oaks Collection*, vol. 2 (Washington, D.C: Dumbarton Oaks Research Library and Collection, 2005), 104.

scalloping for the hair to indicate curls. The saint's name runs down the left and right of the plaque in white letters that are easily legible. The frontality of the saint, his forward gaze, and the sunk enamel technique recall the enamels of the vessels of San Marco, suggesting a date for the plaque sometime in the tenth century.[22]

Overall, the plaque successfully conveys the image of one of Byzantium's most popular saints, and there is little about it that is remarkable save for one thing – its size. At 0.08 x 0.09cm, the plaque is less than a centimeter square. With scale in mind, all the qualities of the Demetrios plaque turn from relatively ordinary to astonishing. The *cloison* wires, which seem almost bulky in photographs, are in fact minute, delicate, and so thin as to leave the viewer wondering how they were shaped. The pattern on the saint's *chlamys* is not a necessary detail but an extraneous one, showing off the ability of the enameller to form and fill the tiny wires. The saint's simplified facial features are carefully calculated structures. The eyebrows and nose, for example, are composed of just a single *cloison* wire. The eyes are nearly perfect circles. Every feature of the plaque is all the more impressive upon recognition that they have been accomplished in miniature.

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[22] Although Marvin C. Ross dated the Demetrios plaque to the eleventh century, the circular eyes and frontality of the figure resemble more strongly the vessels in the Treasury of San Marco, Venice, which are dated to the tenth century. Ross' assertion that the Demetrios plaque parallels the eleventh-century enamels of the Holy Crown of Hungary is not supported by the objects themselves, given that the figures on the crown have almond-shaped eyes and the representation of Saint Demetrios on the crown wears an elaborate military costume rather than the *chlamys*. Ross, *Jewelry, Enamels, and Art of the Migration Period*, 104.

Scale amplifies the impact of the Demetrios plaque in two ways. First, the plaque displays no technical or pictorial missteps, despite its restricted area. The colors of the glass fill are muted from exposure to the elements but remain separated within the confines of their *cloisons*. The *cloisons* are evenly spaced, allowing for fields of color that are large relative to the overall size of the plaque. The saint is immediately identifiable as Demetrios, even without his accompanying inscription, due to the clear representation of his hair and dress.[23] Part of the virtuosity at play in this work is that the enameller did not compromise because of size. Although small-scale would normally be a limiting factor, the enameller has turned the size of the plaque into an opportunity for virtuosic display by maintaining all of the same attributes as a larger enamel. Second, the small size of the plaque concentrates the viewer's attention and encourages close looking. In order for all the details of the plaque to unfold and become visible, a viewer must observe carefully. This close looking allows for the artistry of the plaque to be admired and for the viewer to enter a contemplative state, in which she can meditate upon the saint's image in the course of prayer or other devotional activities. The power of skill and the power of sainthood combine in the Demetrios plaque, paradoxically projecting a charismatic magnetism more often found in monuments than in miniature.

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[23] Without an inscription, the image of Demetrios may appear nondescript to our eyes, but to Byzantine viewers even the slightest detail of curly hair or garment or the combination of the two in representations of saints was identifiable. On this point, see Henry Maguire, *The Icons of Their Bodies: Saints and Their Images in Byzantium* (Princeton: Princeton University Press, 1996), 5-47.

Equally if not more compelling than the Demetrios plaque is a double-sided pendant in the Metropolitan Museum of Art, dated to the twelfth century (Fig. 51).[24] Measuring just 3.3 x 2.4cm, the pendant represents on one side the Virgin Mary ῾Αγιοσορίτισσα (*Hagiosoritissa*, "of the Holy Soros [reliquary]"), an image of the Virgin associated with her relics housed in the monastery of Blachernai and the Church of the Chalkoprateia in Constantinople. On the other side is an image of Christ, Ὁ βασιλεύς τῆς δόξης (*Ho basileus tēs doxēs*, "The King of Glory"), indicated by the inscription on the pendant's lobes. The Virgin stands in three-quarter view with her hands extended in supplication towards a tiny, now heavily damaged hand of God in the upper right corner of the pendant. Christ, facing frontally, gestures in speech or blessing, as if answering his mother's entreaty.

The pendant is impressive due to the simultaneous use of full enamel for the Virgin and sunk enamel for the figure of Christ. Byzantine artisans frequently used sunk and full enamel at the same time, as can be seen on the lid and interior of the Limburg *staurothēkē*, where sunk enamel is used for figural representations and full enamel used for ornaments. As Helen Evans has pointed out, this technical choice also has symbolic dimensions. The enameller has placed the Virgin on a full enamel blue background (now partially lost) accompanied by green lobes to signify her presence on earth, while the gold background provided by the sunk enamel situates Christ in the realm of heaven.[25] Remarkably, the enamel has been applied to both sides of a single sheet of gold (rather

[24] On the date of the pendant see Helen Evans, "Double-Faced Enkolpion," in Evans and Wixom, *The Glory of Byzantium*, cat. no. 112, 165.

[25] Evans "Double-Faced Enkolpion," 165.

than enameling on two separate substrates and soldering them together afterward).[26] The enameller has shown a remarkable economy of material and exhibited his ability to work in two techniques on one substrate without error. Moreover, like the Demetrios plaque, the pendant displays fine, elegant linework with regularly spaced *cloisons* that cease to look like cells and instead approximate drawing with metal.

Regularity and uniformity of line and shape is another feature of small-scale Byzantine enamel that signifies virtuosity. In goldsmithing, repeated shapes are often fashioned with tools known as jigs, templates that restrict the forming of material into a predetermined shape. Some small Byzantine enamels instead show signs of their regular patterns being formed freehand, *without* the assistance of jigs or other tools. One example is an eleventh- or twelfth-century tip of a reading pointer (Fig. 52). The pointer is an elongated ovoid shape resembling a thimble in shape and size (2.5 x 1.3cm). It glistens with color and pattern, its excellent condition a testimony to how highly it was valued. Grids of transparent green enamel divide the pointer into rectangular fields around its body and wedge shapes at its rounded tips. The fields on the body are filled with two alternating patterns, one composed of geometric crosses and the other of florets and circles, both in opaque blue, white, and red. On the rounded tip, the wedge-shaped fields alternate with rosettes and vine patterns. The bottom lobes of the pointer are also filled with abstracted representations of vines. One would assume, based on the regularity and consistency of the patterns that they were shaped with the assistance of tools like a jig. A close look at the construction of the *cloisons*, however, reveals minute inconsistencies (Fig. 53). In the fields with the geometric cross pattern, the arms of the red crosses vary

[26] Evans "Double-Faced Enkolpion," 165.

ever so slightly in length and width. The blue geometric shapes also vary, and no two are exactly alike. Even the red circles inside the blue shapes appear rough on close inspection. Likewise, in the fields with the florets, the lobes of each floret are irregular. None of these inconsistencies are visible without magnification, but they are evidence that the extremely uniform patterns on the pointer were constructed freehand rather than with tools, an astounding feat of manual dexterity and precision.

The same uniformity is exhibited by a temple pendant dated to the eleventh or twelfth centuries (Fig. 54). This small, crescent-shaped object measures 4.9 x 2.4cm (including its suspension loop) and would have been worn near the temple or cheek attached to the wearer's hair or a headdress. The obverse of the pendant represents a beardless youth in a medallion of transparent green ringed with red upon a field of white with red florets. A blue border interspersed with red triangles and red and white palmettes surrounds the central field. The very edge of the pendant is bordered by a transparent green grid that resembles that on the pointer. The reverse of the pendant is a triumph of variegated patterns. Grids of blue frame the edges, followed by white florets on a red field. The central crescent depicts abstract vines shaped into hearts, the hearts arranged into a cross. Like the pendant, each pattern betrays slight inconsistencies, from uneven sizes for the red triangles on the obverse to slight variations in the size and thickness of the vines on the reverse. These irregularities are consistent with freehand fabrication and testify once again to the virtuosity of the enamellers who constructed such delicate objects.

On the opposite end of the spectrum, large enamels came with their own technical challenges, which Byzantine enamellers masterfully overcame. In enameling, a physical

restriction known as the "coefficient of expansion" limits maximum size. The coefficient of expansion refers to how certain materials expand upon heating and contract upon cooling. Metal and glass expand and contract at different rates, making it necessary for the enameller to control the cooling speed so that the glass and metal contract at close to the same rate. Keeping the coefficient of expansion low prevents the glass fill from cracking and detaching from the metal substrate. The most effective way to achieve this goal is by reducing the surface area of the metal, that is, by keeping the enameled objects small. Large objects generally have a high coefficient of expansion, and thus run the risk of damage because the metal and glass cool and contract at significantly different rates. Byzantine enamellers remained undeterred, however, and sought ingenious methods of controlling the coefficient of expansion even on enamels of a large scale.

One such enamel is an eleventh-century plaque representing the Crucifixion (Fig. 55).[27] At 24.3 x 17.5cm the plaque is impressively large, its size surpassed only by the grandeur of the enameling across its surface. Christ hangs outstretched upon a cross of ultramarine blue, attended by his mother, John the Evangelist, the Roman centurion Longinus, and a mourning woman. Like the Fieschi-Morgan *staurotheke* (see Chapter One), the Munich plaque depicts the moment that Christ speaks, with inscriptions to either side of His torso reading "Behold your son, behold your mother" (John 19:26-27). Longinus has already pierced Christ's side, and Christ's blood flows into a vessel beside

[27] The enamel has sustained some damage, particularly to Christ's torso, which has been restored with colored wax. David Buckton, "Byzantine Enamels in Bavaria," *Mitteilungen zur Spätantiken Archäologie und Byzantinischen Kunstgeschichte* 2 (2000): 93–105.

the Virgin Mary. Longinus gestures to Christ, acknowledging the moment of his conversion to Christianity. Above Christ, four angels grieve and lament, while below the hill of Golgotha (indicated by a small skull) soldiers divide Christ's clothing.

The enameling on the plaque is some of the finest to survive from the Middle Byzantine period. The glass fill of the enamel is mostly opaque with the exception of some transparent green for the haloes of the angels and John the Evangelist, the hill of Golgotha, and accents on the soldiers' shields. There is a notable variety of color, with rich red, turquoise, blue, and yellow predominating. The figures are rendered delicately. Their gestures are expressive; their proportions are even and measured. Each figure is individualized; no two figures are formed from the same colors or pattern. Even the angels, which appear relatively uniform at first, vary in the placement of color in their clothing and the feathers of their wings. A plethora of chevrons make up the mantles of the women and the robes of John the Evangelist, while vine patterns wind across the soldiers' leggings. The enameller has spared no detail; even the soldiers' shields are decorated with jewels, birds, and a griffin.

The Munich Crucifixion amazes even without a consideration of technical constraints, but even more impressive is the creativity with which the enameller solved the problem of the coefficient of expansion. The composition has been carefully calculated. There are the same number of figures to either side of the cross, and the vertical division of space continues beneath the cross in the figure of the central soldier, who sits with Christ's robes in his lap. The figures are also more or less arranged into three horizontal registers, with the angels at the top, mourners in the middle, and soldiers at the bottom. There is a careful ratio of enameled areas to metal support, and this even

distribution has allowed for the coefficient of expansion to remain low even on an object of such large size. Not only has the enameller created an elegant, symmetrical, and balanced visual composition for this poignant scene, but he also arranged the composition in such a way that the technical execution of the enamel would be successful.

Similar compositions to the Munich Crucifixion can be seen in the spectacular enamels of the top register of the Pala d'Oro, the high altar retable of the church of San Marco in Venice (Fig. 56). Comprised of six scenes associated with Easter and the principal feasts of the Orthodox liturgical calendar, the plaques likely once adorned a templon beam before being disarticulated and incorporated into the Pala d'Oro.[28] The plaques are the largest extant Byzantine enamels; each measures approximately 30 x 30cm. Like the Munich Crucifixion, the enamels of the Pala d'Oro rely upon clever compositional arrangements to overcome the coefficient of expansion. In particular, the enameller chose to divide the scenes into horizontal and vertical axes to distribute the rate of glass expansion evenly across the surface of the gold substrate.

A plaque representing the Ἀνάστασις (*Anastasis*, "Resurrection") typifies the composition common to the Pala d'Oro enamels (Fig. 57). The scene shows the moment that Christ descends triumphantly to the underworld and raises Adam and Eve out of Hell. Solomon, David, and John the Baptist look on. Christ forms a strong focal point and divides the plane of the gold substrate into two halves. While the figures to Christ's left number three, the scene is balanced to Christ's right by the addition of his billowing robes and an inscription. Like the Munich Crucifixion, the ratio of enameled space to

[28] H. R. Hahnloser, ed. *Il Tesoro di San Marco I: La Pala d'Oro* (Florence: Sansoni editore, 1965), 5.

negative space is relatively equal. A plaque inscribed Ἡ Βαϊοφόρος (*Hē Baiophoros*, "The Palm-Bearing") and showing the Entry into Jerusalem displays a similar composition (Fig 58). Christ once again is the focus, sitting slightly higher than the other figures and tilting his head toward the child in an olive tree who forms the main vertical axis of the composition. Despite the composition being weighted to the right, with an assembly of palm-bearers filling an architectural frame, the amount of enameled space is balanced by the linear depiction of rolling hills and shrubbery. Finally, a plaque representing the Κοίμησις (*Koimēsis*, "Dormition [of the Virgin]") epitomizes the careful symmetry at work in the Pala d'Oro enamels (Fig. 59). In this depiction of the death of the Virgin Mary and the assumption of her soul to heaven, the figures are clustered in the bottom of the frame to either side of the bier. Christ, holding the swaddled form of his mother's soul, occupies the vertical axis. The bottom-heavy composition is stabilized by two attending angels, architectural forms, and the inscription in the upper portion of the plaque. Together, the Pala d'Oro enamels and the Munich Crucifixion make clear that Byzantine enamellers understood the risks inherent in creating large enamels and devise a solution using carefully balanced compositions that regularized the proportion of enameled to plain metal surfaces.

One final strategy employed in large enamels to mitigate the risk of cracking and detached fill is the proliferation of *cloisons*. Both the Munich Crucifixion and the enamels of the Pala d'Oro exhibit a proliferation of *cloison* wires, particularly in the figures' drapery and in the creation of elaborate patterns. In the *Anastasis* plaque, the figures' haloes abound with palmettes and vines, and in the Entry to Jerusalem plaque the white expanse of the donkey's flanks is adorned with sinewy curled *cloison* wires to

suggest the animal's rippling muscles. These additional *cloisons* are unnecessary for the representation of the given scenes. While they amplify drama and affect mood by adding directional movement, they also anchor the glass fill and prevent enamel loss. The *cloisons* act as insurance to guarantee the integrity of the enamel.

Line, Rhythm, and Pattern

Cloisonné enameling is a graphic art by default. The construction of cells from wires set on their edges dictates that the designs composed in this technique will be linear. Just because the design will be linear, however, does not necessitate that the lines of the *cloisons* be elegant, only that they maintain their structure. In enameling, forms cannot be modeled using color and light as in painting or manuscript illumination. Therefore, line becomes a crucial means of articulating expression and movement. Through line, Byzantine enamellers created a sense of visual rhythm, in which they repeated lines in particular shapes to draw the viewer's eye in specific directions. As observed in both small and large enamels, linework was also critical in the construction of patterns. When filled with glasses of alternating colors and translucencies, the shapes created by *cloisons* could create variety and effects of light without the need for modeling. Line, rhythm, and pattern are essential to the virtuosity of Byzantine enamel because, like scale, the challenges imposed by them are not intrinsic to the successful execution of the enameled work. Rather, the fine, sophisticated linework seen in Byzantine enamel evinces a desire to exceed practical implementation and use line for the purpose of artistic expression.

Some of the most understated, yet effective linework in Byzantine enamel appears on an object known as the Holy Crown of Hungary (Fig. 60).[29] Now part of the crown jewels of the Hungarian state, this composite object is formed from a lower crown, the *corona graeca*, and an upper crown, the *corona latina*.[30] The lower *corona graeca* is a masterpiece of Byzantine enameling, with figural enamels representing Christ, the Archangels Gabriel and Michael, Saint George, Saint Demetrios, Saint Kosmas, Saint Damian, and, most notably, portraits of the Byzantine emperor Michael VII Doukas (r. 1071 – 1078), his son Constantine Doukas (r. 1074 – 1078), and the Hungarian king Géza I (r. 1074 – 1077). The inclusion of the portrait of Géza provides a secure date for the production of the enamels of the *corona graeca*. The upper *corona latina* is a Western medieval addition, and David Buckton dated it to the twelfth century based on a careful analysis of its enamels.[31] Much ink has been spilled relating the two parts of the crown to each other and determining the occasion of the crown's arrival in Hungary.[32] Cecily Hilsdale has persuasively argued that the *corona graeca* of the Holy Crown was part of the bridal trousseau of an unknown woman of the aristocratic Synadenos family who

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[29] The bibliography on the Holy Crown of Hungary is vast. The most relevant and recent studies include David Buckton, "The Holy Crown in the History of Enamelling," *Acta historiae artium Academiae Scientiarum Hungaricae* 43 (2002): 14–21; Endre Tóth and Károly Szelényi, *The Holy Crown of Hungary: Kings and Coronations* (Budapest: Kossuth, 2000); Zsuzsa Lovag et al., *The Hungarian Crown and Other Regalia* (Budapest: Hungarian National Museum, 1986).

[30] Tóth and Szelényi, *The Holy Crown of Hungary*, 11.

[31] Buckton, "The Holy Crown," 19.

[32] Arguments are summarized neatly in Tóth and Szelényi, *The Holy Crown of Hungary,* 35-46; Lovag et. al., *The Hungarian Crown*, 21-29.

married Géza I as part of diplomatic negotiations between the Byzantine Empire and the kingdom of Hungary.[33] Because of their secure date, the enamels of the Holy Crown have become anchors in the stylistic dating of other Byzantine enamels.[34] They are, however, rarely analyzed on their own or appreciated for what they convey about Byzantine technical approaches to enameling more generally.

The enameled plaque on the *corona graeca* representing the Archangel Michael exemplifies a minimalistic yet impactful use of line typical of the enamels of the Holy Crown (Fig. 61). The archangel stands in three-quarter view and looks upwards towards the central enamel of Christ enthroned on the crown. He wears imperial garments of opaque blue with a bejeweled golden collar. A robe of translucent blue edged in yellow drapes over one arm, and the feathers of his wings alternate between pale opaque blue and deep translucent red. There is a careful balance of linear forms in the representation of Michael. The angular chevrons of his garments contrast with the gentle roundness of his collar, hair, and wings. The contrast of repeated curved and pointed shapes results in a pleasing variety within the restricted space of the representational field, in keeping with Byzantine aesthetic values. The lines also work to draw the viewer's gaze in specific directions. The focal point is the archangel's pointed gaze towards Christ, indicated by the subtle tilt of his head, the teardrop shape of his eyes, and his soft upwards glance. Read left to right, the chevrons and draping in the archangel's robes push the viewer to first look down at his hands, which gesture towards his own right arm, where more

[33] Cecily J. Hilsdale, "The Social Life of the Byzantine Gift: The Royal Crown of Hungary Re-Invented," *Art History* 31, no. 5 (2008): 602–31.

[34] See for example, n22 of this chapter.

chevrons draw the viewer's eye up to his face. This almost circular motion encouraged by the lines of the *cloisons* finally results in the viewer meeting the archangel's gaze and directing her own towards Christ as well. As if the chevrons were not enough, the lines of the feathers on the very tips of Michael's wings point directly towards his eyes and the direction of his gaze, reinforcing the sightlines at play in the enamel.

The lines of the portrait of Géza I on the opposite side of the *corona graeca* operate similarly. The king of Hungary faces forward in bust form, holding a cruciform staff in one hand and a sword in the other. He wears a bright red *chlamys* over a blue and yellow garment spangled with green jewels, and a jeweled diadem on his head. As on the plaque representing the Archangel Michael, there is a delicate balance of forms in the portrait of Géza. Square gems contrast with the round circles and heart-shaped ivy leaf pattern on his *chlamys*. The figure's high round cheekbones offset the jagged, pointed lines of his substantial beard – a small detail that gestures towards Géza's foreignness. Like the Archangel Michael, the focal point of this representation of the Hungarian king is his emphatic sideways gaze, which falls upon the portrait of Constantine X Doukas and indicates Géza's submission to the pair of Byzantine emperors that his portrait accompanies. Here once more line does work to direct the viewer to follow Géza's gaze. The heart-shaped ivy leaf pattern on the ruler's *chlamys* points insistently upwards towards his face, encouraging the viewer to meet his eye and follow it. The minimalistic use of line on the enamels of the Holy Crown of Hungary act as a visual cue, moving the eye of the viewer together with the eyes of the figures to direct the total experience of the crown itself.

In contrast to the elegant minimalism of the enamels on the Holy Crown of Hungary, a contemporary work in Byzantine enamel shows line, rhythm, and pattern employed to maximal effect. A plaque now incorporated into the Khakhuli Triptych in the State Museum of Fine Arts in Tbilisi represents Christ crowning the emperor Michael VII Doukas and his Georgian wife, Maria of Alania (Fig. 63). Christ is shown framed by the heavenly firmament, indicated by a field of pale opaque blue enamel dotted with stars. He sets diadems upon the heads of Michael and Maria, who stand frontally and stare out at the viewer. An inscription between them reads, in Christ's voice, Στέφω Μιχαὴλ σὺν Μαριάμ χερσι μου (*Stephō Michaēl sun Mariam chersi mou*, "I crown Michael and Maria by my hand"). Michael and Maria wear the male and female versions of the imperial *lōros* over robes adorned with an ivy leaf pattern. On both figures, the edges of the *lōros* is decorated with teardrop-shaped white pearls and studded with large, multicolored and variously shaped gems. Michael's *lōros* wraps around his torso and drapes gracefully over one arm while Maria's is folded into a shield-like shape at the front of her body. In this double portrait plaque, line has been used to arrange the bodies of the two rulers into pure pattern, so that their forms stand in stark contrast to the uninterrupted sheen of the gold background. As in the portrait of Géza, the ivy leaf pattern of their robes points upwards towards the rulers' faces and eventually to the presence of Christ above them. The repeated shapes of the pearls that swing out from the edges of the *lōroi* provide a complementary horizontal rhythm, so that the directionality of the pattern remains balanced and in harmony. As in measures that enamellers took to effectively manage scale, this proliferation of pattern not only secures the glass fill to the

metal substrate, but also allows the enameller to exhibit his skill and ability to fashion so many small, uniform shapes.

On the enamels of the Holy Crown of Hungary and the portrait plaque of Michael and Maria, line is employed both as a compositional strategy that directs the viewer's eye to the intended focal point and as pattern. The careful juxtaposition of round and angular shapes, verticality and horizontality maintains a sense of visual equilibrium. Even in the most densely patterned compositions, the implementation of line and rhythm maintains a sense of order and stability. This sense of order was not just a preference in Byzantine systems of representation, it was a fundamental social value tightly woven into every aspect of Byzantine culture.

Cloisonné and *Taxis*

As outlined in my Introduction to this study, Byzantine enameling is best characterized by the near exclusive use of the *cloisonné* technique. By the twelfth century, when Byzantine enameling had reached its apex of virtuosity, *cloisonné* applied on gold had fallen out of favor in the rest of the medieval world. The workshops of Limoges in what is now southwestern France and enamellers in the Meuse Valley in modern-day Belgium churned out mass-produced, but still luxurious, works of *champlevé* enameling on copper.[35] From a technical perspective, *champlevé* enameling is significantly easier. The

[35] On Limoges enameling see John P. O'Neill, ed., *Enamels of Limoges: 1100-1350* (New York: Metropolitan Museum of Art, 1996). On Mosan enameling, see Neil Stratford, *Catalogue of Medieval Enamels in the British Museum*, 2: *Northern Romanesque Enamel* (London: British Museum Press, 1993).

metal substrate can be simply engraved into compartments, and there are no fussy wires to form, set, and solder. The margin for error is comparatively low, given that cells are not at risk of bleeding if not properly secured to the substrate, nor can engraved compartments snag and break when being polished with lapidary tools, as is the case with *cloisons*. The Byzantine commitment to *cloisonné* enameling was outmoded, and seemingly outpaced by a new technique, yet Byzantine enamellers persisted in executing spectacular *cloisonné* compositions for centuries after the advent of *champlevé* in the medieval West. I contend that two reasons for Byzantine artisans' steadfast commitment to the *cloisonné* technique were first, because the visual effect of *cloisonné* is one of restriction, structure, and organization, and second precisely because of its difficulty.

In addition to its inherent linearity, *cloisonné* enameling demands careful attention to the placement of both glass and metal in order for the design to be successful. *Cloisonné* enameling is repetitive, requiring that the enameller construct similar if not identical forms over and over to create evenly shaped cells. In a sense, *cloisonné* enameling is rigid and regulated, necessitating that the enameller maintains a calculated, consistent level of precision. The total achievement of *cloisonné* enameling is the recognizable visualization of tight control over both the properties of materials and the principles of design. The visualization of control evident in *cloisonné*, I argue, was intentional. It conformed to Byzantine standards of beauty and enacted a principal Byzantine conception of the proper orderly function of the universe – a value known as *taxis*.

In the preface to the tenth-century *Book of Ceremonies*, a manual for Byzantine court protocol, the author (or compiler) laments the loss of order that prompted him to compose the work:

> Perhaps this undertaking seemed superfluous to others who do not have as great a concern for what is necessary, but it is particularly dear to us and highly desirable and more relevant than anything else because through praiseworthy ceremonial the imperial rule appears more beautiful and acquires more nobility and so is a cause of wonder to both foreigners and our own people. Over a long time many things can disappear which, while achieved in that time, are also consumed by it. Among these was the treatise outlining the imperial ceremonial, something valuable and important. Because this had been neglected and become, so to speak moribund, the imperial power was in fact unadorned and unattractive to look at. For just as when a body is not harmoniously fashioned, but has its limbs set in a contorted and ill-coordinated way, one would describe this as a disorder, so too when the imperial administration is not led and governed by order (τάξει [*taxei*]), it will differ in no way from an ignorant and servile way of life.[36]

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[36] Ἄλλοις μέν τισιν ἴσως ἔδοξεν ἂν τουτὶ τὸ ἐγχείρημα περιττόν, οἷς οὐ τοσαύτη τῶν ἀναγκαίων φροντίς, ἡμῖν δὲ καὶ λίαν φίλον καὶ περισπούδαστον καὶ τῶν ἄλλων ἁπάντων οἰκειότερον, ἅτε διὰ τῆς ἐπαινετῆς τάξεως τῆς βασιλείου ἀρχῆς δεικνυμένης κοσμιωτέρας καὶ πρὸς τὸ εὐσχημονέστερον ἀνατρεχούσης καὶ διὰ τοῦτο θαυμαστῆς οὔσης ἔθνεσί τε καὶ ἡμετέροις. Πολλὰ γὰρ οἶδε τῷ μακρῷ χρόνῳ συναπολήγειν, ὡς ἐν αὐτῷ πραχθέντα καὶ ὑπ᾽ αὐτοῦ δαπανώμενα, μεθ᾽ ὧν καὶ τὸ μέγα χρῆμα καὶ τίμιον, ἡ τῆς βασιλείου τάξεως ἔκθεσίς τε καὶ ὑποτύπωσις, ἧς παροραθείσης καί, οἷον εἰπεῖν, ἀπονεκρωθείσης, ἀκαλλώπιστον τῷ ὄντι καὶ δυσειδῆ τὴν βασιλείαν ἦν καθορᾶν. Ὥσπερ γὰρ σώματος μὴ εὐσχημόνως διαπεπλασμένου, ἀλλὰ φύρδην καὶ οὐκ εὐαρμόστως τῶν μελῶν αὐτῷ συγκειμένων ἀταξίαν ἄν τις τὸ τοιοῦτον προσείποι· οὕτω καὶ τοῦ βασιλικοῦ πολιτεύματος μὴ τάξει ἀγομένου καὶ κυβερνωμένου, κατ᾽ οὐδὲν διοίσει τῆς ἰδιωτικῆς καὶ

In this preface, the author observes that the lack of proper imperial ceremony had led to chaos and disorder at the Byzantine court, likening the dysfunction of the court to the deformation of a body. Order (*taxis*), according to the author, is synonymous both with beauty and the proper functioning of the Empire as a whole. The notion of *taxis* was one of the foundational pillars of Byzantine society. *Taxis* structured Byzantine attitudes towards the governance of the earthly realms of nature and civilization, and was formational in the Byzantine perception of the spiritual realm of the soul and heaven.[37] *Taxis* manifested in the organization and behavior of military troops, the imperial court the church, and in art.[38] The opposite of *taxis*, αταξία (*ataxia*, "disorder"), was repugnant and reserved for the behavior of heretics, barbarians, and the diseased.[39]

ἀνελευθέρου διαγωγῆς. Ann Moffatt and Maxeme Tall, eds.and trans., *The Book of Ceremonies* (Queensland: Australian Association for Byzantine Studies, 2012), 3–4.

[37] On spiritual *taxis,* see Stratis Papaiouannou, "Byzantine Mirrors: Self-Reflection in Medieval Greek Writing," *Dumbarton Oaks Papers* 64 (2010), 81-101.

[38] On *taxis* in the military see the *Taktika* of Philotheos in Nicolas Oikonomides, ed. and trans., *Les listes de préséance byzantines des IXe et Xe siècles. Introduction, texte et commentaire* (Paris: Éditions du Centre national de la recherche scientifique, 1972), 83. On *taxis* in the imperial court and imperial art see Maguire, "The Heavenly Court," 247-58; Henry Maguire, "Images of the Court," in *The Glory of Byzantium: Art and Culture of the Middle Byzantine Era, A.D. 843-1261*, ed. Helen C. Evans and William D. Wixom (New York: The Metropolitan Museum of Art, 1997), 183–91; Marie-France Auzépy, "Les aspects matériels de la *taxis* byzantine," in *Bulletin du Centre de Recherche du Château de Versailles* 1 (2005) : http://journals.openedition.org/crcv/2253 ; DOI : 10.4000/crcv.2253, accessed 9 October 2019.

[39] On *ataxia*, particularly in Byzantine art, see Maguire and Maguire, *Other Icons*, 135-56.

In Byzantine art, *taxis* was portrayed through the use of proper proportion, hieratic scale, organized and stable compositions, and minimal, confined movement.[40] Scale and organized compositions were essential in Byzantine enameling not only for their ability to overcome technical constraints but also in their aesthetic presentation. Portions of a revetment, or frame, for an icon of the Virgin Mary embody *taxis* in all of its visual splendor (Fig. 64). Now divided into seven plaques split between the Metropolitan Museum of Art in New York, the Louvre in Paris, and the State Museum of Fine Arts in Tbilisi, the revetment is an astounding work of full enamel cloisonné. Once mounted on an icon of the Virgin *Hagiosoritissa*, the frame bursts with vines and blossoms in shades of emerald green, ultramarine, yellow, white, red, and perhaps most remarkably, a rare soft translucent purple (Fig. 65).[41] Unlike the small enamels that displayed signs of freehand fabrication, the plaques of the revetment are so mechanically precise that they suggest careful work with jigs or templates. Each green leaf is precisely the same size and proportion, each circle that joins a blossom is perfectly round, and each area of negative space is filled with enamel of a complementary color to those around it.

The plaques of the revetment reiterate the Byzantine understanding of enamel as an imitation of natural processes of generation, their mixed opaque and translucent jewel tones evoking precious stones as surely as they depict abundant flora. Yet rather than

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[40] Maguire, "Images of the Court," 185.

[41] Helen Evans, "Revetments from an Icon of the Virgin Hagiosoritissa," in Evans and Wixom, *The Glory of Byzantium*, cat. not. 236, 348-49. For a hypothetical reconstruction of the icon and a discussion of its original appearance see Bissera Pentcheva, *The Sensual Icon*, 98-100.

imitating nature illusionistically, the enamel of the revetment visualizes the control and the placement of nature into perfect, harmonious order. The almost mathematic perfection of the *cloisons* evokes a sense of sacred geometry, as if the enameller of this particular piece were divinely inspired. On the arched plaques of the Virgin's halo, the underlying force at work in this orderly arrangement of natural forms is revealed in the composition of small green crosses that link medallions filled with vines (Fig. 66). Hidden in plain sight, the crosses convey that the precise, exact forms of the vines and blossoms on the revetment participate not only in the natural world, but also in the divine. The cloisonné technique has brought nature into a state of perfection, not only representing the epitome of cosmic *taxis*, but also echoing the goals of Byzantine alchemy to rearrange and perfect matter.

Skill as Technological Power: An Icon of the Archangel Michael

Few Byzantine enamels can rival the perfection of the icon revetment, but a final work testifies to the ingenious skill of Byzantine enamellers. An eleventh-century icon representing the Archangel Michael, now in the Treasury of San Marco in Venice is the most accomplished work of Byzantine enamel to survive to the present day (Fig. 67). The entire icon measures at 46 x 35cm and is constructed of no less than fifty-seven individual plaques. Roundels depicting Saint Peter, Christ, and Saint Menas adorn the top of the icon, while pairs of military saints including Theodore the General, Theodore the Recruit, Demetrios, Nestor, Prokopios, George, Eustatios, and Merkurios adorn the sides of the frame. The size and number of enamels on the icon are impressive enough, but the most remarkable aspect of the icon is that the archangel is represented in relief and

enameled in three dimensions, a technique known as *en ronde bosse*. While not the only three-dimensional Byzantine enamel, the icon of the Archangel Michael is certainly the most successful and the most impressive.[42]

Behind Michael, the enamels of the background engage in a visual play with scale. None of the enamels are, in fact, that large, but their use of pattern and their uniformity gives them a sizeable appearance. The organization of the background plaques into numerous small details, florets for the "sky" and vines for the "earth," lends the background plaques a sense of infinite expansion. There is a deliberate juxtaposition of pattern, with the florets structured into disciplined rows and the vines curling into organic tendrils, separating the orderly realm of heaven from the sprawling chaos of earth (Fig. 69). The two are separated by the body of the archangel, who simultaneously occupies both realms.

The archangel stands frontally, his gaze meeting the viewer head-on. He holds a sword in one hand and a *globus cruciger* in the other. His ornate armor is composed of individual enameled *lamellae* (scales), in alternating rows of palmettes and florets. The ends of his kilt flare outwards, as if he has only just ceased flight. His wings, forearms, and legs are executed in near-flawless gold *repoussé*. The greatest technical and artistic triumph of the icon, however, is in the delicate rendering of the archangel's face and hair (Fig. 68). Michael's face is fully encased in seemingly soft, flesh colored enamel with the slightest *cloison* lines indicating his chin and ears. The thinnest *cloison* wires, almost appearing as a crack, outlines the contours of his throat. His eyes and brows are defined

[42] A twelfth-century relief icon of Saint Demetrios, surviving in poor condition, is housed in the Kunstgewerbemuseum in Berlin.

by the minute *cloison* wires. The swirled pattern of his curls is outlined with *cloisons* of two different sizes. Large, thick *cloisons* mark the separation of each ringlet, while thin *cloisons* trace individual hairs. His diadem is topped with a single, perfectly round seed pearl. All of this has been achieved upon gold hammered into relief, and the effect is striking. The icon of the Archangel Michael exemplifies the extent of technological power that Byzantine enamellers possessed and displayed. The choice to represent the archangel in relief pushes the bounds of what is possible using *cloisonné* enameling. Here enamel quite literally embodies a being, the archangel, who made solely of spirit and fire.[43] The work pushes beyond the graphic tendencies of *cloisonné* and into the realm of sculpture.[44]

Conclusion

To demonstrate their mastery over materials and the constraints of physics, Byzantine enamellers flaunted their virtuosity. This virtuosity was conspicuous, visible for all to see in the handling of scale, line, and in the arrangement of material into orderly, measured pattern. As outlined by James Trilling, this conspicuous virtuosity was tied to the imitation and manipulation of nature, and was a crucial Byzantine strategy for the communication of power. Byzantine enamellers demonstrated that power when they

[43] Glenn Peers, *Subtle Bodies Representing Angels in Byzantium* (Berkeley: University of California Press, 2001).

[44] On the theological dimensions of relief icons and their phenomenological perception see Bissera Pentcheva, "Moving Eyes: Surface and Shadow in the Byzantine Mixed-Media Relief Icon," *RES: Anthropology and Aesthetics*, no. 55/56 (2009): 222–34; Bissera Pentcheva, "The Performative Icon," *The Art Bulletin* 88, no. 4 (2006): 631–55.

created enamels of minute and expansive size, overcoming the limits set by space and physics. Byzantine enamellers used line, rhythm, and pattern to create dynamic movement and expression in an otherwise static, graphic art form. The cloisonné technique appealed to Byzantine artisans and audiences despite its technical difficulty, because it held the potential to control matter itself and bring it into order – a fundamental Byzantine social value. The virtuosity of Byzantine enamel culminated in objects like the icon of the Archangel Michael, which pushed enameling to its very limits and exhibited total technological mastery over the material world.

Conclusion

In the tenth-century *Book of Ceremonies*, a Byzantine manual for court protocol, the author (or compiler) recounts the preparations for receiving ambassadors in the Great Palace of Constantinople. In the reception hall known as the Magnaura, ambassadors approached the emperor, who sat on a mechanized throne adorned with lions, and birds in golden trees, called "The Throne of Solomon." The scenario is described as follows:

> When the *logothete* [a high-ranking court official] puts the customary questions to him [i.e., the ambassador], the lions begin to roar, and the birds on the throne and likewise those in the trees begin to sing harmoniously, and the animals on the throne stand up on their bases. While this is taking place in this way, the foreigner's gift is brought in by the protonotary of the post [another court official] and again, after a little while, the organs stop and the lions subside and the birds stop singing and the beasts sit down in their places. After the presentation of the gift, the foreigner, directed by the *logothete*, makes obeisance and goes out, and while he is moving away to go out, the organs sound and the lions and the birds each make their own sound and all the beasts stand upright on their bases.[1]

[1] καὶ ποιοῦντος τοῦ λογοθέτου τὰς συνήθεις ἐρωτήσεις εἰς αὐτὸν, ἄρχονται βρυχᾶσθαι οἱ λέοντες καὶ τὰ ὄρνεα τὰ ἐν τῷ σέντζῳ, ὁμοίως καὶ τὰ ἐν τοῖς δένδρεσι, ᾄδειν ἐναρμονίως· τὰ δὲ ζῶα τὰ ἐν τῷ θρόνῳ ἀπὸ τῶν ἰδίων βαθμῶν ἀνορθοῦνται. καὶ ἐν τῷ ταῦτα οὕτως τελεῖσθαι εἰσάγεται τὸ τοῦ ἐθνικοῦ κανίσκιον ὑπὸ τοῦ πρω τονοταρίου τοῦ δρόμου, καὶ πάλιν μετ' ὀλίγον παίουσι τὰ ὄργανα, καὶ οἱ λέοντες ἠρεμοῦσι, καὶ τὰ ὄρνεα τοῦ ᾄδειν παύονται, τά τε θηρία τοῖς ἰδίοις τόποις ἐγκαθέζονται. καὶ δὴ μετὰ τὴν συμπλήρωσιν τοῦ κανισκίου ὑπὸ τοῦ λογοθέτου προτραπεὶς ὁ ἐθνικὸς προσκυνήσας ἐξέρχεται, καὶ ἐν τῷ τοῦτον ἀποκινῆσαι ἐξελθεῖν τά τε ὄργανα αὐλοῦσιν καὶ οἱ λέοντες καὶ τὰ ὄρνεα τὴν ἰδίαν

The Byzantine account is corroborated by that of Liutprand, Bishop of Cremona (c. 920 – 972), who visited the Byzantine court as part of an Ottonian embassy in 949. In his memoir about his time in Constantinople, he recounted:

> In front of the emperor's throne there stood a certain tree of gilt bronze, whose branches, similarly gilt bronze, were filled with birds of different sizes, which emitted the songs of the different birds corresponding to their species. The throne of the emperor was built with such skill in such a way that at one instant it was low, then higher, and quickly it appeared most lofty; and lions of immense size (though it was unclear if they were of wood or brass, they certainly were coated with gold) seemed to guard him, and, striking the ground with their tails, they emitted a roar with mouths open and tongues flickering.[2]

These two descriptions of a throne adorned with automata and other hydraulic devices evoke an image of the Byzantine court as a place full of technological wonders. By all accounts the "Throne of Solomon" was a spectacular sight, and by virtue of its fantastical nature the throne has always featured in scholarly studies of Byzantine technology.[3]

ἕκαστον ἀποπληροῦσι φωνὴν, καὶ τὰ θηρία πάντα τῶν ἰδίων βαθμίδων διανίστανται.καὶ ἐν τῷ ἐξιέναι τὸν ἐθνικὸν τοῦ βήλου παίουσι τά τε ὄργανα, καὶ τὰ ὄρνεα καὶ τὰ θηρία τοῖς ἰδίοις τόποις ἐγκαθέζονται. Ann Moffatt and Maxeme Tall, eds. and trans., *The Book of Ceremonies* (Queensland: Australian Association for Byzantine Studies, 2012), 569.

[2] Paolo Squatriti, ed., *The Complete Works of Liudprand of Cremona* (Washington, D.C: Catholic University of America Press, 2007), 197–98.

[3] Gerard Brett, "The Automata in the Byzantine 'Throne of Solomon,'" *Speculum* 29, no. 3 (1954): 477–87; James Trilling, "Daedalus and the Nightingale: Art and Technology in the Myth of the Byzantine Court," in *Byzantine Court Culture from 829-1204*, ed. Henry

Less often noted is that the Throne of Solomon was not the first sign of Byzantine technological power that greeted a visitor to the court. Ambassadors would reach the hall of the Magnaura through its courtyard, where decorators had hung textiles in the shape of an arcade, "and the Treasury's enameled objects were also hung on it."[4] Before even laying eyes upon the throne, an ambassador was first met with enamel. As the author of the *Book of Ceremonies* points out, these enamels were not always on display. Rather, they were removed from the imperial treasury and exhibited on an occasion when the full might of the Empire was shown.

The elision of enamel with Byzantine imperial power is evident in another passage from the *Book of Ceremonies*, this time describing the adornment of a different reception hall, the Chrysotriklinos, on the occasion of banquets served to visiting dignitaries:

> In the eight vaults of the Chrysotriklinos were hung the imperial crowns from the Church of the Most Holy Theotokos of the Pharos and the other churches of the Palace, and various enameled objects from the Treasury…Note that the imperial crowns and enameled objects were hung alternately, that is, in the middle an imperial crown and to either side the enameled objects.[5]

Maguire (Washington D.C.: Dumbarton Oaks Research Library and Collection, 1997), 217–30.

[4] …καὶ ἐκρεμάσθησαν ἐν αὐτῷ καὶ τὰ χειμευτὰ ἔργα τοῦ φύλακος. Moffatt and Tall, eds. and trans., *The Book of Ceremonies*, 571.

[5] εἰς δὲ τὰς ὀκτὼ καμάρας τοῦ χρυσοτρικλίνου ἐκρεμάσθησαν τὰ τοῦ ναοῦ τῆς ὑπεραγίας Θεοτόκου τοῦ Φάρου στέμματα καὶ τῶν ἑτέρων ἐκκλησιῶν τοῦ παλατίου, καὶ ἔργα διάφορα χειμευτὰ ἀπὸ τοῦ φύλακος… ἰστέον, ὅτι τὰ στέμματα καὶ τὰ χειμευτὰ ἔργα ἓν

As in the decoration of the Magnaura, the enamels in the Chrysotriklinos were brought out from the treasury not just to decorate, but also to articulate notions of the Empire's power. Assuming that these objects were made of gold, as most Byzantine enamels were, it might be easy to dismiss this presentation of enamel as a mere show of wealth. Wealth certainly was an aspect of Byzantine power that enamel was equipped to communicate. However, the inclusion of enamel in the decoration of the Magnaura and the Chrysotriklinos can also be seen as part of a broader program announcing the scientific knowledge and technological ability that sustained Byzantine imperial control.

Enamel in Byzantium was more than just a luxury art, it was the materialization of power. Between the ninth and twelfth centuries, enamel became associated with the practice of alchemy as evinced in the vocabulary used to describe it, χυμευτός/χειμευτός (*chymeutos*/*cheimeutos*) and ἔργα χυμευτά/χειμευτά (*erga chymeuta*/*cheimeuta*). In the same era, Byzantine practitioners of alchemy included recipes for enameling among the texts they composed and compiled in the course of their work. Alchemy in medieval Byzantium was a precursor to modern science, in which practitioners sought to identify and manipulate the behaviors of matter in nature. As part of that project, they turned to the knowledge of materials acquired through artistic labor. As part of this "artisanal turn" in Byzantine alchemical inquiry, enameling emerged as the perfect embodiment of alchemical processes and goals, including the dissolution and reconstitution of matter; the change of physical qualities, such as color; and, ultimately, total transmutation.

παρ' ἓν ἐκρέμαντο, ἤγουν μέσον στέμμα καὶ ἔνθεν κἀκεῖθεν ἔργα χειμευτά. Moffatt and Tall, eds. and trans., *The Book of Ceremonies*, 580-81.

Enameling took ordinary, mundane materials such as sand and metal, and irreversibly transformed them into brilliant, multicolored objects that captivated the senses and the intellect.

Beyond its dazzling appearance, enamel appealed because of its epistemological potential. In Byzantine alchemical thought, processes of making were also a means of learning and knowing about the world. Through making enamel, Byzantine artisans imitated, and thus revealed an intimate knowledge of, natural creative processes – particularly the generation of stones deep within the earth as theorized by Plato, Aristotle, and Theophrastus. Byzantine alchemical texts categorized enamel as a type of imitation stone, and as products of a technology of artificial replication. Byzantine enameled objects not only assumed the appearances of gems, they were understood to be the product of the same processes, albeit engineered by humans rather than generated by nature. As an act of human artifice, enameling allowed for artisans to intervene at will and manipulate the creative processes they imitated, resulting in objects that gradually and surpassed their natural prototypes and revealed the superior skill of human hands at work.

Byzantine enamellers cultivated skill as a means of demonstrating their capacity to overcome material and physical limits, and to arrange matter itself into harmonious order. To exhibit skill they made enamels of extreme size, both small and large, surmounting challenges posed by restricted space and the demands of physics. The Byzantine preference for *cloisonné* enameling allowed for the use of line, rhythm, and pattern to articulate movement and expression in defiance of technical constraints that could otherwise result in static, lifeless representation. By virtue of its restrictive and

organized nature, the *cloisonné* technique lent itself to the articulation of broader Byzantine social values, such as the notion of order, or *taxis*. The virtuosity of Byzantine enamel was conspicuous and performative, announcing the ability of Byzantine artisans to control and systematize the material world.

Perhaps, then, it is not so strange that the Byzantines announced their power to foreign rivals through the display of enamel, nor was that display merely a signifier of wealth and prestige. More subtle than the Throne of Solomon, but no less powerful, Byzantine enamel articulated Byzantine knowledge and command of the world they sought to rule.

Appendix I.

"By the Same (Psellos). To the Patriarch Kyr Michael [I Keroularios] Concerning How One Should Make Gold"[1]
Eleventh Century

MSS Consulted: Paris gr. 2325 (thirteenth century), Paris gr. 2327 (after 1478)
Edition: "L'êpitre sur la Chrysopée." In *Catalogue des manuscrits alchimiques grecs*, edited by Joseph Bidez, 4:1–47. Brussels: M. Lamertin, 1932.

Translated by Shannon Steiner.
Translation edited by Charles Kuper.

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1. Ὁρᾷς, ὁ ἐμὸς δυνάστης, ὅ με ποιεῖς, ἡ τῆς ἐμῆς ψυχῆς τυρρανίς, ἀπο τοῦ τῆς φιλοσοφίας μεγέθους ἐπὶ τὴν ἐμπύριον καταβιβάζων τέχνην καὶ πείθων τὰς ὕλας μετακινεῖν καὶ τὰς φύσεις μεταποιεῖν, εἰ καὶ τοῦτο ἴσως φιλόσοφον καὶ τῆς περὶ τὴν φύσιν ἐπιστήμης ἠώρηται. Πολλοὶ μὲν οὖν τελεστικὸν τοῦτο ἤγηνται καὶ ἀπόρρητον καὶ ἐς οὐδεμίαν ἀνάγειν τῶν λογικῶν ἐπιχειροῦσι τεχνῶν· ἐγω δε, πάλαι μὲν καὶ αὐτὸς θαυμάζων τὸ πρᾶγμα, τὰ μὲν οὐκ ἐδίδουν τοῖς λεγομένοις τὸν νοῦν, τὰ δὲ μετὰ τῶν τεράτων ενόμιζον· ἐπεὶ δέ μοι τὸ ἔργον ἐπέταξας, ὥσπερ τις Εὐρυσθεύς, τὰ χρυσᾶ σοι μῆλα μετενεγκεῖν τὸν μόλιβδον ἀποχρυσοῦντα ἢ τὸν καττίτερον ἢ ἄλλο τι τῶν ἀποτελεσμάτων τῆς φύσεως, ὅπερ εἴωθα εἰς πᾶν ἔργον ποιεῖν, ἐπὶ τὸν λόγον

1. You see, my lord, my soul's sovereignty, what you're doing to me by lowering me from philosophy's greatness to the lowly fire-craft and ordering me to transform matter and transmute natures, even if this [practice] has elevated a philosopher to the knowledge of Nature.[2] Now many have concluded that this [practice, i.e. alchemy] is mystical and occult, and therefore make no effort to ascend to any of the [higher] logical sciences. I, on the other hand – I have marveled at what has been done for a long time. I paid no mind to what was said, but I have believed it to be [one] among the wonders. And since you put this task upon me, just like a second Eurystheus,[3] to retrieve golden apples for you – making gold from lead or tin, or some

[1] Alternative title in Paris gr. 2325: τοῦ μακαρίου καί πανσόφου ψελλοῦ ἐπιστολὴ πρὸς τὸν ἁγιώτατον πατριάρχην τὸν ξιφιλίνον περὶ χρυσοποιίας (By the Blessed and All-Wise Psellos. Letter to the Most Holy Patriarch [John VIII] Xiphilinos Concerning Chrysopoeia).

[2] A reference to Aristophanes' *Clouds*, in which Socrates is suspended in the air in a basket.

[3] In Greek mythology, Eurystheus imposed the twelve labors on Heracles. The eleventh labor, referred to here, required Heracles to obtain the golden apples of the Hesperides.

πρῶτον ἐβάδισα τὰς αἰτίας τῶν γινομένων ζητῶν, ἵν᾽εἰ μὲν ἀφορμὴν εὔλογον εὕρω τῶν συμβαινόντων, ἐκεῖθέν τε τοῦ πράγματος ἄρξωμαι καὶ μετ᾽ἐπιστήμης θηράσωμαι τὴν κατάληψιν, ἢν δὲ μη, χαίρειν ἐασω τὰ δρώμενα.

other of the creative processes – as I do in every endeavor of mine, I have first proceeded according to reason, seeking the causes for the effects, so that if I find a sensible origin for what occurs, I might proceed from there to my task and hunt my quarry with knowledge. But if not, I'll let what happens be.

2. Οὕτω τοίνυν σκοπῶν καὶ διερευνώμενος καὶ πρὸς ἕτερον ἀφ᾽ἑτέρου χωρῶν, ἐπ᾽αὐτὴν τὴν φύσιν τῶν λεγομένων στοιχείων ἀνέδραμον ἀφ᾽ὧν τἄλλα συνίσταται καὶ πρὸς ἃ λυόμενα ἀναλύεται. Ὠιήθην γὰρ οὐκ ἀλόγως ὅτι τὰ ἐκ τούτων συγκείμενα, ἀφ᾽ὧν ἄρα γεγόνασιν, ἐκεῖθεν καὶ τὰ πάθη εἰλήχασιν. Πάντων δὲ τὴν τῶν τεσσάρων κρᾶσιν ἐχόντων, τὰ μὲν ἀπὸ γῆς μᾶλλον ὠνόμασται, ὅσα γεηρὰ καὶ ἐπίξηρα, τὰ δ᾽ἐξ ἀέρος τὴν κλῆσιν εἴληχεν, ὅσα κουφότερα καὶ πνευματικώτερα, τὰ δὲ τῆσ ἐμπύρου οὐσίας καθέστηκε μέτοχα, ὅσα θερμότερα καὶ στιλπνότερα, τὰ δὲ τῆς ὑγρᾶς οὐκ ἀποβέβηκεν, ὅσα γλισχρὰ καὶ τὴν φύσιν ὀλισθηρὰ ἢ ὅσα στύφειν καὶ πυκνοῦν εἴωθεν καὶ τραχύνειν τὴν ἐπιφάνειαν, ἃ προδήλως θαλάττης ἔργα καθέστηκεν· αὕτη δὲ τῶν ἄλλων ὑδάτων στοιχειωδέστερον· οὐδὲ υὰρ οἱ ποταμοὶ γεννῶσι τὴν θάλασσαν ὥσπερ οἱ πολλοὶ οἴονται, ἀλλ᾽ἐκεῖθεν διὰ μέσων τῶν ἀτμῶν οὗτοι πληρούμενοι εἶτ᾽αὐξηθέντες, ἐκεῖσε συνπιρρέουσιν. Εἴ τι γοῦν παχύτερον ὂω ὑγρότερον γέγονεν, οὐδὲν ἄλλο ὅ τι μὴ γῆ τυχάνον ὕδωρ ἐγένετο· καὶ εἴ τι λεπτότερον ὂν ἢ μανότερον πυκνότερον ἔγνωσται, τοῦτο ἢ πῦρ τυγχάνον εἰς ἀέρα μεταβέβληται, ἢ ἀὴρ εἰς ὕδωρ, ἢ ὕδωρ εἰς γῆν.

2. So therefore, through study and analysis, I moved from one thing to another, and I returned to the nature of what are called "elements," from which all else is composed and into which it is dissolved and recycled. For I believed, and not unreasonably, that what was composed of these elements, also receives its allotted properties from the very things from which they are generated. Every thing possesses a combination of the four [elements]: some are mainly named after the earth, whatever is earthy and dry; others take their name from the air, whatever is lighter and more vaporous; others partake of the essence of fire, whatever is hotter and more flickering; others can be none other than water, whatever is sticky and slippery by nature, or whatever tends to contract and condense and roughen the appearance [of surfaces]: This is clearly the work of the sea. [The sea] represents the nature of this element better than other waters. It is not, in fact, the rivers that generate the sea, as most believe, but through the evaporation of the sea the rivers swell and then once grown are all poured into the sea. If, therefore, something more solid becomes more fluid, the reason can only be that what was earth became water. Likewise, if something thinner and more rarefied becomes denser, this was fire that was transformed into air, or air into water, or water into earth.

3. Ἐζήτουν οὖω εἰ καὶ παρὰ τοῖς πρώτοις στοιχείοις ἡ αὐτὴ μεταβολὴ εὕρηται. Ὠιμην γὰρ ὡς, εἰ τὸ πῦρ ἀὴρ γίγνοιτο καὶ ὁ ἀὴρ ὕδωρ καὶ τὸ ὕδωρ γῆ καὶ τὸ αὐτὸ ἀνταποδιδοίν ἡ ἐκ τῶν κάτω πρὸς τὰ ἄνω μεταβολή, οὐδεν καινὸν ἂν εἴη εἰ καὶ τὰ μὲν γεηρότερα ὑδατωδέστερα γίγνοιτο, ταῦτα δὲ ἀερώδη, κἀκεῖνα ἐμπύρια. Οὑτω τοίνθν εἰς τὴν φυσικὴν ἀναβὰς ἐπιστήμην καὶ τοῖς τελεωτέροις τῶν φιλοσόφων καθομιλήσας, εὗρον ὡς ἐξ ἀλλήλων τε τούτοις ἡ γένεσις καὶ θάτερον γεννᾷ θάτερον (παράλληλα γὰρ κείμενα πάσχει τε καὶ ποιεῖ), πυκνότητες δὲ καὶ μανότητες τὰς φύσεις αὐτῶν ἐξαλλάτουσι· τὸ μὲν γὰρ ὕδωρ πηγνύμενον λιθοῦται εἰς κρύσταλλον, τὸ δὲ λεπτυνόμενον ὕδωρ ἐστι, καὶ τοῦτο εἰς ἀτμίδα λυόμενον ἀὴρ καθίσταται, ὃς δὴ θερμαινόμενος εἰς πῦρ ἄντικρυς τελευτᾷ· τὸ δὲ πῦρ αὖθις ψυχόμενον οἷον εἰς ἀέρος φύσιν ἐξήλλακται, καὶ οὗτος πυκνούμενος εἰς νεφέλας συνίσταται καὶ ὕδωρ ἐστὶν οὐράνιον, καὶ τοῦτο ἄνω μὲν πηγνύμενον χιὼν ἢ χάλαζα γίνεται, κάτω δὲ κρύσταλλος.

3. I was therefore considering whether the same change should not also occur with the primordial elements. I thought, in fact, that if fire becomes air, and air [becomes] water, and water [becomes] earth, and that symmetrically, the same change occurs in reverse, that is from what is lower to what is higher, there is nothing strange if what is more earthy becomes more watery, and what is more watery becomes airy, and what is more airy becomes fiery. So I went to the natural sciences, and I became familiar with the most prestigious philosophers, I discovered that the elements are generated reciprocally and each produces the other (in contact they act and undergo action), and that the thickening and the rarefying alter their natures: when water freezes, it solidifies into ice; there is also rarefied water, but this evaporates into vapor and becomes air, and when the air becomes warm, it immediately turns into fire. In turn, as fire cools down, it is as if it were changed into the nature of air, and as the air thickens, it condenses into clouds and is water from the sky, which, when it freezes up there, becomes snow or hail, while down here, it becomes ice.

4. Ἐγὼ γοῦν αὐτος ἐθεασάμην οὐ πάνυ πρὸ πολλοῦ χρόνου (ἔφηβος γὰρ τότε ἦν ἢ καὶ πρόσω, καὶ τὰ προτέλεια, τῆς φιλοσοφίας μυούμενος) ῥίζαν, ὡς οἶμαι, δρυὸς ἀκριβῶς εἰς λίθον μεταβληθεῖσαν, καὶ ἦν θαυμάσιον τὸ δρώμενον· μεταίχμιον γὰρ ἀμφοτέρων τῶν φύσεων ἦν· διείληπτο μὲν γὰρ ἰνώδεσιν ἀποφύσεσι κατὰ τὴν τῶν δένδρων οὐσίαν, στεγανῷ τε κελύφει κατακεκάλυπτο, τὰ μὲν ῥυσσούμενον, τὰ δὲ καὶ εἰς ὀμφαλίτιδας πόρους δεικνύμενον· τὸ δ᾽ὅλον ἀντιτυπὲς

4. Not long ago I saw a root (I was little more than a young man, and I had only been initiated into the introductory rites of philosophy) I believe, of a tree, perfectly transformed into stone. It was a wondrous sight, something halfway between both natures. It was marked, in fact, by fibrous growths, according to the essence of trees, and covered all around with a hard shell, partly wrinkled, partly having navel-like pores, however, it was entirely hard, pure stone.[4] Back then I was simply amazed

[4] Here the word choice for "hard," αντιτυπές, is a play on words, meaning both "resistant" and "of another nature."

ἦν καὶ λίθος καθαρῶς. Τότε μὲν οὖν ἁπλῶς θαυμάσας ἀφῆκα· ὕστερον δὲ γενναιότερον τῇ φιλοσοφία προσβάς κεραυνῷ βεβλῆσθαι ἡγησάμην τὴν δρῦν, οὐ τῷ καυσώδει τούτῳ δὴ καὶ μελαίνοντι, ἀλλα τῷ λεπτοτέρῳ καὶ ταχυτέρῳ, ὃς δὴ ἀθρόον τοῖς τῆς δρυὰς προσελάσας πόροις καὶ τὴν ἰκμάδα πᾶσαν ἐξαναλώσας, την τε ἐν τοῖς πόροις ἀερώδη οὐσίαν ἐκδαπανήσας, τό τε διεστηκὸς συνέσφιγξε τῶν ἰνῶν καὶ εἰς λίθου στερρότητα τὴν ὕλης μανότητα μετεποίησεν. Ὁ μέντοι γεωγράφος Στράβων ἱστορεῖ καὶ φύσιν τινὰ ψυχροτάτης πηγῆς τὴν τοιαύτην ἀντιτυπίαν ταῖς μανοτέραις ἐντιθέναι τῶν φύσεων ὃ πολὺ θαυμασιώτερον τῶν ἐκ τοῦ πυρὸς μεταβολῶν πέφυκεν.

5. Ἐπεὶ οὖν ἱκανῶς ἡμῖν πεπροοιμίασται ὡς αἱ τῶν ὑλῶν μεταβολαὶ φυσικήν τινα ἀλλοίωσιν ἔχουσιν καὶ οὐκ ἐξ ἐπῳδῆς τινος ἢ τερατείας ἢ ἄλλης ἀρρητουργίας (διὸ καὶ θαυμάζειν οὐ χρή), ἐπ᾽αὐτὴν ἤδη σοι τὴν τέχνην χωρῶ τῆς μεταβολῆς. Ἐβουλόμην μὲν οὖν καθολικήν τινά σοι τεχνολογίαν ποιήσασθαι καὶ πᾶσαν ὑλουργίαν διερευνήσασθαι, πύκνωσίν τε φύσεων καὶ ἀραίωσιν χρωματουργίαν τε καὶ ἀλλοίωσιν, διδάξαι τε τί μὲν τὸ τὸν κρύσταλλον ἀραιοῦν, τί δὲ τὸ τὸν ὑάκινθον, καὶ πῶς ἄν τις καὶ σμάαγδον οὐκ ὄντα ποιήσῃ καὶ βήρυλλον, τίς δὲ ἡ φύσις τοῦ τὰς λίθους ἁπάσας μαλάττοντος, καὶ πῶς μὲν ἡ μαραγρῖτις λυθείη καὶ εἰς ὕδωρ ἀναλυθείη, πῶς δ᾽αὖθις συμπαγείη καὶ σφαιρωθείη, τίς δὲ ὁ λόγος τῆς τούτων λευκάνσεως, καὶ ἁπλῶς μηδὲν καταλιπεῖν ἀνεξέταστον τῶν ἐν τούτοις γινομένων ὑπο τῆς φύσεως, τέχνην τε ποιῆσαι τὸ μάθημα καὶ ὑπὸ κανόνας ἀνενεγκεῖν· ἐπει δὲ συ σχολάζειν ἡμᾶς ἐν τοῖς περιττοῖς οὐκ ἐᾷς οὐδὲ ἐν τοῖς ἀσπουδάστοις καταναλίσκειν πᾶν τὸ φιλότιμον, τοῦτο δὲ μόνον διερευνῆσαι προήρησαι ἐκ τίνων ὑλῶν καὶ διὰ Ποίας τῆς ἐπιστήμης χρυσὸν ἄν τις ποιήσειε, ταύτην μόνην τὴν τεχνολογίαν

and left it alone: but after progressing farther in philosophy, I was convinced that the oak had been struck by lightning, not by the kind which burns and blackens, but by the most rarefied and swiftest. This lightning instantly penetrated the pores of the tree and consumed all the sap, and expended the aerial essence in the pores, and narrowed the space between the fibers, and changed the spongy wood into rigid stone. But, to tell the truth, Strabo, the geographer, tells of the nature of a very cold spring, able to produce a similar hardness in lighter materials, which is a phenomenon much more extraordinary than changes by fire.

5. Since I have sufficiently shown in the introduction that the changes in materials come from a natural alteration and not from some enchantment or prodigy or some other secret manipulation (wonder, therefore, is not the right response), I now turn to the specific mechanism of change. I would have liked to have written a general treatise and carefully explained every operation on matter, that is, the condensation and rarefication of natures, the creation of colors and transformation, and to teach what softens crystal and blue stones, how someone could make green stones or beryls from what is not, and the nature of the substance that removes the hardness of precious stones, and how a pearl can disintegrate and dissolve into water and then become solid again and spherical, and the reason for their whiteness. In short, I would have liked to leave nothing unexplored of what happens in these subjects through nature, to make this lesson a discipline and systematize it. But you do not allow me to carry out an investigation into the superfluous, to waste my thirst for knowledge on things that are not useful. Because you prefer that I explain only

σοι δίεμι. Ὃ γὰρ πολλάκις ἤκουσας ἐνίων λεγόντων, τοῦτο τεθαύμακας, καὶ οὗ θαυμάζεις τὰς αἰτίας ζητεῖς, οὐχ ἵνα θησαυροῖς πολυταλάντοις ἐπικαθίζῃς, ἀλλ᾽ἵνα ἐντὸς γένῃ τῶν ἀδύτων τῆς φύσεως καὶ θαυμάζῃς αὐτῶν τὰ ἀπόρρητα· φιλοσόφου ψυχῆς ὄντως τὸ ὅρμημα καὶ τὴν ἰδέαν γνωρίζω, καὶ ἄγαμαί σε τῆς πολυπραγμοσύνης, ἣ καὶ τοὺς πρώην φιλοσοφήσαντας, ὧν τὰ πρῶτα ὁ Πλάτων, ἐς τὴν Αἴγυπτόν τε καὶ Σικελίαν καὶ πολλὰ τῆς Λιβύης μέρη μετήνεικεν, ἵνα το τε Αἰτναῖον πῦρ ἴδοιεν καὶ τὴν τοῦ Νείλου ἀνάβασιν, την τε ἄσκιον πυραμίδα καὶ τὰς ὑπογείους σύριγγας ὧν τοὺς λόγους ἐν ἀπορρήτῳ τελουμένους διηρμηνεύκασιν.

this, with what materials and through what science we can make gold, I will discuss only this technique. You have been amazed at what you have often heard various persons speak of, and you seek the causes for what has amazed you—not to sit upon hoards of treasure, but to enter into the inner sanctuaries of Nature and gaze upon its mysteries. I recognize the spirit and essence of your truly philosophical soul, and I am pleased with your curiosity[5]: a curiosity that has led the philosophers of the past, and first Plato, to Egypt, Sicily, in many parts of Libya, to see the fire of Etna, the flooding of the Nile, the pyramid that does not cast a shadow, and the underground tunnels, and they provided explanation to the accounts for these phenomena that had previously been mysterious.

6. Οἶδ᾽ὅτι δυσχεραίνεις τὰ παρεισόδια, βουλόμενος πρὸ τῶν περιρραντηρίων τὸν νεὼν κατιδεῖν. Τῶν μὲν οὖν προτελείων σοι ἅλις· ἰδού δέ σοι ἀνέῳκται καὶ τὰ ἄδυτα. Ἀλλὰ βραχύ τι περίμεινον αὖθις. Ὥσπερ οὖν οὐκ ἓν είδος τῆς τέχνης ποιεῖ τὸν τελεστὴν ἢ τὸν φιλόσογον, οὕτως οὐδὲ τὸν χρυσὸν μιᾶς τινος ὕλης ἀπεργάζεται δύναμις, ἄλλοι δὲ ἄλλως ποιοῦσι, καὶ τὰ μὲν ἀποτελοῦντα πολλά, τὸ δὲ ἀποτελούμενον ἕν. Ἀλλ᾽ἐγὼ οὐκ ὅπερ εἴωθεν ὁ ἐλέφας ποιεῖν ἐνδείξομαι σοι.

6. I know that digressions annoy you—I know that you want to see the inner sanctuary before the outer entrances and the fountains for purification. Therefore, stop with the initiatory rites: behold, the doors to the temple's penetrals stand open before you.[6] However, stop for a moment. Just as no single kind of art makes an initiator or a philosopher, so the power of a single material does not make gold, each power works in a different way. What produces it [i.e. gold] are many, but

[5] The term πολυπραγμοσύνη is another double entendre, indicating both curiosity and bad motives.

[6] The complete architectural metaphor here is likely a reference to the *Physika kai Mystika* of Pseudo-Democritus. In the *Physika kai Mystika*, the secrets of alchemy are kept in books hidden in the inner sanctuary of an Egyptian temple. A second reference to Pseudo-Democritus in section 14 also makes mention of a temple. See Matteo Martelli, *The Four Books of Pseudo-Democritus* (Leeds: Maney, 2013), 83-85. Also see discussion of the *Physika kai Mystika* in Chapter One.

Τοῦτο γᾶρ τὸ ζῷον ἐξάντη τινὰ ταῖς τῆς κεφαλῆς ὀδύναις ἐκ τοῦ ἄσθματος δύναμιν κέκτηται. Οἱ τοίνυν αὐτῷ συνθέστεροι, πληγέτες οὕτως τὴν κεφαλήν, εἶτα δή τι τῶν τροφίμων αὐτῷ ὡς μισθὸν κομιζόμενοι, τὸ πονοῦν τῷ στόματι ὑποβάλλουσιν· ὁ δ᾽ ἦν μὲν ἵδη τὸ δαπάνημα ἀξιόλογον, οὐκ ἅπαξ ἀλλὰ καὶ δίς, ἴσως καὶ τρίς τὰς γένυς ἀνοίγνυσι καὶ ἐμφυσᾷ τῷ ὀδυνωμένῳ·ἢν δ᾽ ἄλλως εὐκαταφρόνητον, ἐσάπαξ αὐτῷ τὸ πνεῦμα ἀφίησιν. Ἀλλ᾽ ἐγώ τοι πολλάκις ὥσπερ αἱ ἐπάδουσαι προσεπανοίξω τὸ στόμα, ἄλλο ἐπ᾽ ἄλλῳ ἆσθμα προσαφιείς. Δεῖ γάρ μοι καὶ πολλοῦ πνεύματος· ἤδη γάρ με ἐπί τῆς καμινιαίας καθέδρας ἐκάθισας, τὴν χώνην καὶ τοὺς ἐμβολαίους προετοιμάσαντα.

the result singular. But in my demonstration, I will not do what the elephant is accustomed to do. This animal has a certain power, from its breath, that heals headaches.[7] Those who are familiar with this animal and suffer from a headache, bring him some food as a payment, and place their aching head under his mouth. The elephant, if he considers the remuneration worthy, opens his jaws, not just once but twice, and perhaps even three times, and blows on the suffering; but if the remuneration does not seem sufficient to him, he invests him with his breath only once. I, on the other hand, will continue to open my mouth repeatedly, like the enchantresses, and I will release gust on gust. But I have need of much breath because you have now set me to the furnaces to prepare the crucible and the molds.[8]

Recipe 1 for creating gold

7. Πρώτη τοίνυν αὕτη δημιουργία χρυσοῦ. Ἄμμος τίς ἐστι παραλία χρυσῖτις καλουμένη ἀπὸ τοῦ χρώματος· οἱ δὲ τοῦτο αὐτο χρύσαμμον ὀνομάζουσι. Ταύτην δεῖ λειοῦν ἐν στεγανῇ τινι θυίᾳ καὶ χνοώδη ποιεῖν, εἶτα δὴ ψύχειν καὶ ἐξικμάζειν, ὡς μὴ τὰ χνοώδη μέρη συμφύεσθαι. Ἐπεὶ δὲ στύφειν καὶ θερμαίνειν χρεών, ἅλατι μὲν στῦφε, πυρὶ δὲ θέρμαινε ἡμέραν καὶ νύκτα μὴ ἀφαιρούμενοσ· εἶτα τὴν θυίαν λαβών, ὕδατι κλύσας τὴν ἅλμην, ἀπόθου τὸ φάρμακον, εἶτ᾽ αὖθις τὸ ἄγγος ἐπὶ τοῦ πυρὸς θείς, φύρασον ὄξει τὸν χνοῦν στάγδην ἐπιρραίνων, ἵν᾽ ὁμοῦ τέγγοιτο καὶ ξηραίνοιτο. Τοῦτο δὲ τετράκις ποιήσας,

7. The first process of making gold is the following. There is a coastal sand called chrysite by the color: it is also known as chrysammus.[9] It must be finely ground on a very hard stone mortar, made into a very fine powder, then cooled and kept dry, so that the small particles do not join together. Next it is necessary to abrade it and heat it: abrade it with salt, and heat it with fire for one day and one night in succession. Then, take the mortar, rinse the salt away, and put the preparation back inside. Then return the container to the fire, mix the powder with some vinegar, sprinkling it slowly drop by drop,

[7] Possibly an allusion to Pliny's *Natural History*, bk. XXVIII, ch. 24, in which Pliny claims elephants are known to heal headaches with the touch of their trunks.

[8] Here Psellos likens his "breath" to that of a set of bellows.

[9] A yellow or golden color.

αὖθις ἐτέρωθι διηρημένως ἄργυρον λύσας καὶ μόλιβδον, ἄμφω τῇ θυίᾳ ἐπίχεε, μέχρις ἂν διαχεθῶσιν εἰς ἄλληλα καὶ συμπλακῶσιν εἰς ἕν, εἶτα προσαφελὼν καὶ ψύξας ἐφ᾽ ὥραις τρισί, τὸ σύμπαν ὄψει σκληρόν, εἶτα δὴ ψάμμῳ καθάρας, εὑρήσεις χρυσόν.

so that it dries at the same rate that it becomes wet. After you have repeated the process four times, separately melt down silver and lead and pour both into the mortar, until they are fused together and are combined into one entity. Then remove it from the fire and let it cool for three hours. When you see that the mass has solidified, clean it with sand-[substance], you will find gold.

Recipe 2 for creating gold

8. Εἰ δὲ βούλει, καὶ οὕτω ποίει· σανδαράχην καὶ καλακάνθην καὶ ἀρσενίκην καὶ θεῖον ἄπυρον καὶ κιννάβαριν ὁμοῦ συντρίψας τε καὶ λειώσας, καὶ γλοιῶδες τὸ μῖγμα ποιήσας, εἰς καθαρὰν ἔμβαλε ὕελον ἧς τὸ στόμιον ἔστω στενώτερον, ὁποῖα δή εἰσι τὰ θηρίκλεια, καὶ τὸ στόμα ἐμφράξας πηλῷ, θέρμανον μεθ᾽ ἡμέραν πυρί, εἶτα δὴ ἀφελών τὸν πηλόν, εὑρήσεις ξηρὸν τὸ μῖγμα καὶ πίττῃ τὴν σύστασιν ἐοικός. Τοῦτο οὖν αὖθις λειώσας, εἰς κεραμεοῦν ἀγγεῖον μετάγγισον, καὶ ὅλον περιλαβὼν θὲς ἐγγύθι πυρός, καὶ ἀνακαλύψας εὑρήσεις ξανθόν, καὶ τοῦτο εἰς χώνην μεταβαλὼν πύρωσον, καὶ ἀργύρου μέρος ἐπαφες· εἶτα τήξας καὶ ψύξας εὑρήσεις χρυσόν.

8. You may also make gold this way. Grind together and emulsify sandarac,[10] blue vitriol, orpiment, unburnt sulphur, and cinnabar. Make the mixture viscous and pour it into a clean glass container with a rather narrow neck, just like a Thericlean vase. Plug it with clay and heat it for a day on fire. Then remove the clay and you will find the mixture dry and similar, in consistency, to pitch. Emulsify it again and transfer it to a terracotta container. Take the whole vessel and place it next to the fire. When you uncover it, you will find a yellow mass. Pour it into a crucible, put it to heat, and add a measure of silver. After you have melted it and let them cool, you will find gold.

Recipe 3 for making gold

9. Καὶ μαγνησίαν δὲ εἰ λάβοις λευκὴν καὶ ἴσον ὄγκον ψήγματος ἄριστα προοικονομηθέντος, εἶτα δὴ ἄμφω λεάνας ῥαφανίνῳ ἐλαίῳ πέψειας, ἔσται σοι τὸ ἑκ τῆς χωνείας χρυσός. Εἰ δὲ μὴ στίλβει τῷ χρώματι, ἄλατι χρίσας καὶ μίσϋι καὶ σιδήρου ἰῷ σὺν ὄξει λειανθεῖσι καὶ τὰς δυνάμεις κοινώσασι, τῶν ἐκ τοῦ

9. You may also take white magnesia and an equivalent weight of gold powder processed according to the best standards, if you emulsify the two ingredients with horseradish oil and cook them, what comes from the crucible will be gold. If it doesn't shine with luster, grease it with

[10] Arsenic sulfide or red arsenic sulfide. See Dioscorides *De Materia Medica*, bk. V, ch. 122.

Πακτωλοῦ ψηγμάτων χρυσοειδέστερον ἀπεργάσαιο.

salt, misy,[11] and iron rust, diluted with vinegar and with [other substances] that distribute their properties. You will have made [something] that looks as good as gold powder from Pactolus.[12]

Recipe 1 for multiplying gold

10. Εἰ δε, χρυσὸν ἔχων, διπλάσιον τὸν ὄγκον ποιῆσαι θελήσειας μηδὲν ἀφελὼν τῆς ποιότητος, τοῦτον διασταθμήσας, δύο τούτου ἀντιστάθμησον διπλάσια φάρμακα μίσυ καὶ ἐβένινον ῥίνημα, ὡς εἶναι τὸ ἐξ ἀμφοτέρων τοῦ χρυσοῦ τετραπλάσιον· ταῦτα μίξας ἢ ἀνακράσας περίπλασον τῷ χρυσῷ, καὶ οὕτως εἰς χώνην ἐμβαλὼν καὶ πυρώσας, ἐξένεγκε, καὶ σαυτοῦ πλουσιώτερος γενήσῃ διπλῇ.

10. If you already have gold, and you want to double the amount without decreasing its quality, weigh it and then, counter balance it with a double-portion of misy and a double-portion of ebony filings so that the combined weight is four times that of the gold: mix or amalgamate these substances and spread them around the gold. Put them in the crucible and heat them. Remove them, and you will have doubled your wealth.

Recipe 4 for making gold

11. Ἀλλὰ μὴ λαμπρύνειν μηδὲ αὐξάνειν, ποιεῖν δὲ χρυσὸν ἐπιτετράμμεθα. Τοῦτο δὴ καὶ αὖθις ποιήσω, εἰ καὶ μικρὸν ὁ λόγος παραδραμὼν ἑτερας τέχνας παρεθεώρησεν. Ἡ κιννάβαρις καὶ ὁ χρυσίζων ἰος τοῦ χαλκοῦ, ὥσπερ τινὰ φυσικὰ εἴδη σεληναίᾳ ὕλῃ ἐπιβληθέντα, σῶμα ποιοῦσι χρυσοῦν. Ἂν οὖν ἄργυρον τήξας, τὰ φάρμακα μίξας ἀνακεράσῃς ἥλιός σοι ἡ σελήνη γενήσεται, καὶ τεμών διὰ βάθους εὑρήσεις τὸ χρῶμα καῖ πρὸς

11. But I have been tasked not to beautify or increase gold, but to create it. I will also do this, even if my account digresses a little and takes a sort of "passing glance" at other techniques. Cinnabar and golden copper rust, just as some natural forms receive a "projection" from lunar matter [i.e. silver], make a body golden.[13] If you melt the silver down, mix the preparations together, and then infuse them together. Your "moon" will become

[11] Probably copiapite, a hydrated iron sulfite. See Dioscorides, *De Materia Medica*, bk. V, ch. 117.

[12] A river in Turkey near the Aegean coast, in the region of Lydia, well known in antiquity as a source of gold sediment. See Theodore Leslie Shear, "The Gold Sands of the Pactolus," *The Classical Weekly* 17, no. 24 (1924): 186–88.

[13] Throughout the Greek alchemical corpus, silver is equated with the moon, and gold is equated with the sun. Here the "projection" of lunar matter probably refers to the ability of silver to color baser metals such as lead and copper.

ἅπασαν εὐχρηστίαν ἀποχρυσωθέντα τὸν ἄργυρον. Καὶ σελήνη μὲν ἥλιον, ἥλιος δὲ σελήνην οὐ δρᾷ· μόνη γὰρ αὕτη ἐκεῖθεν ἔχει τὸ φῶς. Οὐ σελήνη δὲ μόνη, ἀλλὰ καὶ Ἀφροδίτη διακονεῖται τῷ μεγάλῳ φωτί. Τὸ τοίνυν τοῦ χαλκοῦ σῶμα ἐλάσας ὅσον εἰκος, οἷά τινα γλῶτταν ἐπιμήκη ἀπέργασαι, εἶτα δὴ ἐπ᾽ἀνθράκων θέμενος, ἐπ᾽αὐτὴν τὸν Ἥφαιστον ὑπερέθιζε, ἐπιρραίνων νῦν μὲν ὀρυκτοῦ ἅλατος <τι> νῦν δὲ Ἀττικῆς ὤχρας ἐφεξῆς ἢ ἐναλλὰξ νῶτα καὶ στέρνα τῆς Παφίας κοσμῶν· ἡ δε σοι καλλίων ἀθρόον γενήσεται, καὶ τὸ γλαυκὸν ἀποβαλοῦσα, φανεῖταί σοι χρυσίζουσα. Τοιαύτην ἄρα ἴσως ὁ Πάρις τὴν Ἀφροδίτην ἰδών, τῆς Ἥρας καὶ Ἀθηνᾶς προτετίμηκεν.

your "sun."[14] If you cut through it you will find the right color and the silver changed into gold suitable for every natural function of gold. The moon produces the sun, but not the sun the moon, because only the moon receives light from the sun [and not vice versa]. But not only the moon, but Venus also receives its light from the great light.[15] So beat a piece of copper, about the quantity to make a long sheet, put it on some coals, and rouse Hephaestus under it. Alternatively sprinkle it with ground-salt, and then Attic ochre, sometimes in that order and sometimes in reverse, as you adorn the chest and shoulders of the goddess of Paphos.[16] It will instantly become more beautiful. It will lose its greenish color and become golden for you. And so, perhaps, Paris saw Aphrodite in that state [i.e. golden], and thus ranked her before Hera and Athena.

Digression on gold paint

12. Ἐπεὶ δὲ οἰκονομίας ἄνω ἐμνήσθημεν, ἑρμηνεύσωμεν τί ποτε δηλοῖ τοὔνομα· διότι γὰρ χρυσίτιδος βαφῆς εἰς τὰ ἔργα δεόμεθα, πρότερον δεῖ ἔχειν τὸ φάρμακον, ἵνα ἐν καιρῷ χρώμεθα. Τὸ γοῦν χρῶμα οὕτω ποιήσεις· ἡ χρυσοκόλλα γῆς ἐστιν ἄνθος ἐν Μακεδονίᾳ φυόμενον· ταύτην ὕδατι γλυκεῖ πολλάκις ἀνακαθάρας, εἶθ᾽ἡλιακαῖς ἀκτῖσι ξηράνας, χαλκοῦ ἰῷ Σκυθικοῦ καὶ χρυσολίθῳ συνανάλυε καὶ συναναμίγνυε· εἶτα δὴ ὑγρῷ περιττώματι

12. We talked more about the "process" [of making gold dust for gilding], so I'll explain what the expression means. For our words we need gold paint, so we need to have prepared substance ready, to use it when it's needed. You will make the color in the following way. The chrysocolla is a flower of the earth that

[14] Silver will become gold.

[15] In this passage Psellos iterates that silver and copper (equated with Venus in the alchemical corpus) can turn to gold, but gold cannot turn into copper or silver. This logic is based on the natural behavior of planets, that is, the moon and Venus can receive and reflect the light of the sun but not vice versa.

[16] Venus/Aphrodite, i.e. copper.

βάπτων, εἰς διαυγῆ φύλαττε ὕελον, καὶ ἡμέραν ὅλην ταῖς τοῦ πυρὸς περιθερμαίνων αὐγαῖς, πύρινον ποιήσειας φάρμακον· ἔχεις ὁμοῦ καὶ τῆς οἰκονομίας τὴν σημασίαν καὶ τὴν ποίησιν τῆς βαφῆς.

grows in Macedonia.[17] Clean it repeatedly with fresh water and dry it in the sun. Then dissolve it with copper rust of Scythia and chrysolite and mix it together. Then add a little urine, store it in a container of clear glass, and heat it for a whole day in the sun's rays. You will have made an igneous substance. You now have both the meaning of the expression and the way to obtain the tincture.

Recipe 5 for making gold

13. Χρυσὸν δὲ καὶ οὕτως ἐργάσαιο· μόλιβδον τήξας πυρί, θεῖον ἄπυρον τούτῳ ἐπίρρανον, καὶ χρῶ τῷ πυρὶ μέχρις ἂν ἡ ἀποφορὰ τοῦ θείου ἐξατμισθῇ· εἶτα δὴ σχιστῆς στυπτηρίας καὶ κινναβάρεως ἰσομέτρους ὄγκους λαβὼν καὶ μίξας ὀξομέλιτι, τηκομένῳ τῷ μολιβδῳ ἐπίρραινε· ὁ δὲ τούτοις καὶ τῷ ἀπύρῳ, τῷ μὲν στερρὸς γεγονώς, τῶν δὲ τὸ χρῶμα δι᾽ὅλων τῶν πόρων λαβών, ἐκ πάντων ἀποτελεσθείη χρυσός.

13. You may also make gold like this. Melt lead over fire, spread it over native sulfur, and keep the fire burning until the sulfur odor dissipates. Then take equal measures of lamellar and cinnabar alum, combine them with sour honey, apply them to the melted lead. The lead becomes hard due to the native sulfur and acquires the color of the other ingredients through its pores, and from all of them it is turned into gold.

Conclusion

14. Τί οὖν; πᾶσάν σοι τὴν Ἀβδηριτικὴν σοφίαν ἀνακαλύψομεν ἐν βραχεῖ καὶ οὐδὲν ἐντὸς τοῦ ἀδύτου ἀφήσομεν; Ἀλλ᾽οὔθ᾽οἱ τελεσταὶ τοῦτό φασιν οὔθ᾽ἡ μυστηριώδης θεαγωγία· χρόνοι δὲ τακτοὶ τὸν μυσταγωγὸν ἐκίνουν καὶ εὐθὺς τῆς βακχείας ἐπαύετο καὶ τὸ σύνθημα οὐ κατήπειγεν ὁ μυούμενος. Ἀλλὰ μὴ δυσχεράνῃς εἰ τῷ πρώτῳ σοι καὶ θείῳ μυσταγωγῷ ἄλλος αὐτὸς μυσταγωγὸς κάθημαι. Σὺ μὲν γὰρ τὰ κρείττω πεπίστευσαι, καὶ κατάγεις Θεὸν καὶ

14. What's that? Will I reveal to you all the wisdom of Abdera all at once and not leave anything inside the sanctuary?[18] But not even the fully-initiated do not say this, nor does the mysterious rite of *theagogia* [reveal this]: Preestablished periods of time inspired the master of the mysteries, and then he suddenly ceased from his Bacchic fury, nor did the initiate hasten for the complete [knowledge]. Don't be offended if I assimilate myself as a mystagogue next to you, the first and

[17] Malachite or borax, often used as a solder for gold. See Dioscorides, *De Materia Medica*, Bk. V, ch. 104.

[18] A second reference to the *Physika kai Mystika* of Pseudo-Democritus; the work was attributed to the fifth-century BCE atomist Democritus of Abdera. See n6, above.

ἀνάγεις ψυχήν, καὶ τὸν νοῦν συμβιβάζεις ἑτέρῳ νῷ τῷ ἐξῃρημένῳ τῶν ἐν τῇ ὕλῃ, ἐγὼ δὲ κάτω ποι ἔρριμμαι καὶ τῆς φύσεώς εἰμι θεωρὸς καὶ οὔπω τοῖς ἀθεάτοις προσέβαλλον, ἐπεὶ μήπω μοι τὸ ὄμμα ὀξυωπέστερον γέγονεν.

divine mystagogue. For you have been entrusted with higher matters. You bring God to earth and raise your soul to heaven. And you join your mind to a mind that is separated from what is material. My place is farther below. I am an observer of nature and I have not yet encountered what is invisible, because my eye has not yet become so keen.

15. Οἶσθ᾽οὖν ὃ ποιήσομεν; Ἐγὼ μὲν τὰ τῆς γῆς πεπίστευμαι ἄδυτα, σὺ δὲ τὰ ἐκεῖθεν τοῦ παντὸς ἐγκεχείρισαι· μεταδῶμεν οὖν ἀλλήλοις ὧν ἔχομεν, σὺ μὲν ἐμοὶ τῶν καλῶν θεαμάτων, ἐγὼ δε σοι τῶν φυσικῶν ἀποτελεσμάτων. Ἀλλ᾽ὁρᾷς ὅπερ ἐγώ σοι πεποίηκα; Χρυσοῦ γὰρ πηγὰς ἀναδούς, οὔτε τὸν Ἄθω διέσεισα, οὔτε τὸ Πάγγαιον μετεκίνησα, οὐδὲ φλέβας τινὰς ὑπογείους χρυσίτιδας ἀνεστόμωσα, ἀλλὰ λίθους ἀλλήλοις ἐντρίψας καὶ πόας δή τινας μίξας, ἀφελῶς σοι καὶ εὐώνως τὸν πολύτιμον ἐξειργασάμην χρυσόν· τοιοῦτόν τι μοι ἀντιμηχάνησον καὶ αὐτός· μὴ εἰς ἀέρα κινήσῃς, μὴ ποιήσῃς μετέωρον, ἀλλά τινι χρησάμενος ἴυγγι, ἐπὶ γῆς μοι δεῖξοντὸ ὑπερουράνιον ἀγαθόν. Τοῦτο γάρ ἐστι μὲν οὐδαμοῦ, πανταχοῦ δὲ καὶ ἐν οἱῳδήτινι μέρει τοῦ παντὸς εὑρισκόμενον λανθάνει τοὺς πολλούς, καὶ τὸ ἐντὸς ἡμῶν ἐν οὐρανῷ ζητοῦμεν πλανώμενοι. Ἀλλ᾽ἑρμήνευσον ὅπως τε ἐγγύς ἐστι καὶ ὅπως πόρρω ἀφέστηκεν, οὐ τόπῳ ἀφεστηκός, ἀλλὰ διαθέσει ἐγγίζον ἢ μακρυνόμενον. Εἰπὲ τίς ὁ λόγος τῆς τοῦ νοῦ καταβάσεως, εἶτα δὴ τοσοῦτον καταβὰς πῶς αὖθις ἐπάνεισι. Τὸ ἐπὶ τούτοις κεφάλαιον, χειραγώγησον πρὸς

15. You know what? I have been entrusted with the secret places of the earth; you were entrusted with the things up there, the universe: let's share what we have with each other—your beautiful contemplations with me, my achievements in the field of nature for you. Do you see what I have done for you? I produced gold springs, without tearing apart Mount Athos or moving the Pangaion Hills, [19] or even opening the way to underground auriferous veins. Instead, by rubbing some stones together and mixing herbs, I created precious gold in a simple and inexpensive way. Please do something similar for me in return. Don't raise me into the air or elevate me into the stratosphere, up, but using a sort of *iunx* show me on earth the super-celestial Good.[20] This Good is in no specific place, but it is everywhere and is found in every part of the universe, though it escapes the notice of the many—like fools, we look in heaven for what is inside us. Explain to me, then, why the Good is both near and remote, not remote in space, but either closer or farther away by the disposition [of the mind/soul]. Tell me the reason for the

[19] Both Mount Athos and the Pangaion Hills, a mountain range in northern Greece, were renowned for their gold deposits in the Middle Ages.

[20] A *iunx* is a wheel or top-like device on a string, often used in antiquity for magical purposes.

Θεόν, εἰ μὲν διὰ τῆς ἄγαν στενῆς, ἀγαπῴην ἄν, εἰ δ᾽οὖν, τῆς χωρούσης ἡμᾶς. Εἰ ταῦτα μοι μυσταγωγήσειας, κατεπαγγέλλομαί σοι πᾶν ὅ τι περίεστιν ἔργον ἐπιστήμης καὶ φύσεως, καὶ οὔτε τί σοι μηχανῆσ εἶδος ἀφήσω οὔτε τῆς πρεσβυτέρας σοφίας καὶ ἀπορρήτου, ἀλλά σοι καὶ τὰ νέρθεν γῆς, εἰ βούλει, συνεξερευνήσομαι· εἰ δὲ ἐγὼ μὲν γενήσομαί σοι φιλοδωρότατος, σὺ δὲ τὴν σὴν ἐπιστήμην οὐ παραδείξειας, χάλκεια χρυσείων μὴ ἀνταλλαττόμενος, οὐδ᾽οὕτως ἀποδυσπετήσω, οὐδὲ γράψομαί σε ἀγνωμοσύνης, ἀλλ᾽εἴσομαι ὅτι ἐν ὑέλῳ μᾶλλον τὸ ἡλιακὸν παρατριβόμενον ὑφάπτεται πῦρ. Βούλει οὖν ἐρεῖν με ὅπερ ἀντὶ πάντων αἰτῶ; Πλέον ἀγάπησον.

soul's *katabasis*, and after it has arrived so low, how it will ascend again.[21] Most importantly, lead me to God. I would prefer [to be led] through the very narrow gate, but in any case, through whatever gate that will admit me. If you should initiate me into these mysteries, I promise you every work that remains of science and nature. I will not leave out any method, no ancient and secret knowledge. If you wish, I will search the depths of the earth with you. If I then bestow more gifts to you, and you instead do not reveal your wisdom, refusing to exchange objects of gold for objects of bronze, I will still not cease [from my duties] nor accuse you of discourtesy.[22] But I will know that the sun's light, when it is focused through a lens, kindles fire all the more. Do you want me to tell you what I ask you for in return for everything I offer you? That you love me more.

[21] I.e., why human souls are inserted into bodies on earth.

[22] A reference to Book VI of the *Iliad*, in which Diomedes and Glaucus exchange speeches and then exchange gold and bronze armor.

Appendix II. A

"Explanation of Enamel," from *On the Most Noble and Renowned Goldsmith's Art*
Eleventh century CE[1]

MSS Consulted: Paris gr. 2327 (after 1478)
Primary edition: Berthelot, Marcellin, and C.E. Ruelle, eds. *Collection des anciens alchimistes grecs*. Vol. 3. Paris: G. Steinheil, 1887, 323.

Translated by Shannon Steiner.
Translation edited by Charles Kuper.

ΕΡΜΗΝΕΙΑ ΤΟΥ ΣΜΑΡΔΟΥ. —Τρίψον λεπτὰ τὸν σμάρδον ἐν τῇ ἀκμώνῃ, καὶ θὲς εἰς κογχύλην· καὶ πλύνον καλῶς. Εἶτα βάλε ἐν τῷ γλύμματι· θὲς αὐτὸ ἐν τῇ πύρᾳ ἐν φουρνελλίῳ σιδηροῦν καθὼς καὶ τὴν ἔγκοψιν ἐν φουρνελλίῳ· ἔστω δὲ τὸ

Explanation of Enamel[2] – Grind the enamel finely on the grinding stone and set it in a shell.[3] Wash it thoroughly. Then

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[1] On the dating of *On the Most Noble and Renowned Goldsmith's Art*, see Jochem Wolters, "Der byzantinische Traktat über die edle und hochberühmte Goldschmiedekunst aus dem 11. Jarhundert," in *Schatzkunst am Aufgang der Romanik: Der Paderborner Dom-Tragaltar und sein Umkreis*, ed. Christoph Stiegemann and Hiltrud Westermann-Angerhausen (Munich: Hirmer Verlag, 2006), 259–84.

[2] As discussed in Chapter Three, the term σμάρδος is the Hellenization of the Italian *smalto*, meaning enamel. The fifteenth-century scribe of Paris gr. 2327, Theodore Pelekanos from Corfu, copied the manuscript on Crete and routinely updated earlier texts by replacing words with their more recent counterparts in dialect. As a result of the Venetian presence on Crete, these emendations frequently take the form of Italian terminology. Pelekanos either corrected this term or made a play on words by adding "αγ" in each instance, transforming σμάρδος into σμαραγδος (*smaragdos*, "green stone"). I thank Gerasimos Merianos for his observations on the etymology of σμάρδος.

[3] In his *Schedula diversarum artium* ("List of diverse arts") (also known as *De diversis artibus* ["On diverse arts"]), the twelfth-century Western monk, Theophilus Presbyter, also specifies putting the ground and washed enamel in a shell: "This you then break up with a round pestle until it is powdered and you wash it, put it in a clean shell and cover

φουρνέλλιον σιδηροῦν πέταλον καμαροειδῶς καὶ κοσκινοειδῶς τετρημένον· καὶ ἔνεγκον αὐτὸ, τρίψον, ὥστε ἴδῃς τὸν ἄσημον μεσμιρεῖν μετὰ μολίβδου ἐν ξύλῳ. Καὶ πάλιν θὲς ἐν τῇ πύρᾳ εἰς τὸ φουρνελλίῳ, να κινήσῃ δεύτερον ὁ σμάρδος.

set it [i.e. the enamel] into the design.[4] Place it into the furnace-fire, setting the niello[5] also in the furnace. The furnace should be [made of] iron sheet-metal with a domed chamber and punched through with perforations.[6] Bring [the bellows] and work it until you see the silver flow with the lead[7] on the wood-[fire]. Set it into the furnace-fire again until the enamel quickens a second time.[8]

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with a linen cloth." *On Diverse Arts,* ed. C.R. Dodwell (Oxford: Clarendon, 1986), 105-6. Shells were easily available and easy to clean.

[4] The Greek term γλύμμα (*glymma*) is usually translated as an engraved figure. Here it likely refers to the design set in *cloisons*.

[5] The directive to place the niello (ἔγκοψιν, *egkopsin*) in the furnace with the enamel may be intended to gauge temperature and firing time. Niello, a lead silver sulfate, melts and fuses more quickly than enamel and can be used to estimate how much longer the enamel should remain in the furnace.

[6] The perforated cover prevents ash and coals from falling into (and corrupting) the enamel. As Theophilus notes, "place this gold setting on a thin iron tray which has a short handle, and cover it with another utensil. This [other utensil] is hollow like a crucible, and is finely perforated everywhere, the holes being large and smooth inside and outside finer and prickly to keep out cinders if they happen to fall on it." *On Diverse Arts*, 106.

[7] The flowing of silver and lead refers to the molten niello, a signal that the fire has reached the correct temperature.

[8] Enameling is a repetitive process. After the enamel is fired, the ground glass contracts and shrinks. More ground glass must be reapplied after each successive firing, until the level of the enamel has built up flush with the *cloison* wire.

Appendix II. B

Excerpt from *The Deep Dyeing of Stones; Green Stones, Red Stones, and Blue Stones According to the Books Taken from the Inner Sanctuary of the Temple*[1]
Eighth to tenth century[2]

MSS Consulted: Paris gr. 2325 (thirteenth century); Paris gr. 2327 (after 1478)
Edition: Berthelot, Marcellin, and C.E. Ruelle, eds. *Collection des anciens alchimistes grecs*. Vol. 3. Paris: G. Steinheil, 1887, 350-64.

Translated by Shannon Steiner.
Translation edited by Charles Kuper.

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1. Λαβὼν κομάρου τοῦ δυσχερῶς εὑρισκομένου, ὃ Πέρσαι καὶ Αἰγύπτιοι τάλακ φασὶν, οἱ δὲ ταλὰκ, ʃ, καὶ θείου ʃ , καὶ ὕδατος θείου ἀθίκτου ʃ ιη′, λείωσον τὸ

1. Take *komaris*[3], difficult to find, which the Persians and Egyptians variously call *tálak* or *talák*[4], half an ounce, and a half-ounce of sulfur, and native sulfur-water[5],

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[1] The title is a direct reference to the *Physika kai Mystika* of Pseudo-Democritus, in which the author describes finding books with the secrets of alchemy in the collapsed column of an Egyptian temple. See Matteo Martelli, *The Four Books of Pseudo-Democritus* (Leeds: Maney, 2013), 83 – 85. See also the discussion of this passage in Chapter One.

[2] I thank Matteo Martelli for his opinion on the dating of this text.

[3] The substance *komaris* is unidentified, but seems to have been a type of mordant or dye fixative. A recipe for *komaris* appears in the eleventh-century manuscript Biblioteca Marciana gr. 299, f. 127v, where it is identified with mercury. Given that the text specifies the *komaris* must be ground and mixed with mercury, in this instance *komaris* cannot be mercury itself.

[4] The Persians and Egyptians mentioned here refer to contemporary Islamic groups. The Arabic and Persian words spelled out phonetically refer to talc rather than the mercury mentioned in the Greek recipe.

[5] This is the "Divine/sulfur water" that seems to have been a necessary component in many of the operations of the Greek alchemical corpus, see Matteo Martelli, "'Divine Water' in the Alchemical Writings of Pseudo-Democritus." *Ambix* 56, no. 1 (2009): 5–22.

κόμαρον καὶ ἕνωσον τῇ ὑδραργύρῳ· καὶ βάλε εἰς ἀνακλαστάριον ἀγγεῖον ὑάλινον, καὶ ἔχε.

18 ounces. Grind the *komaris* to a powder and mix it with mercury. Put it in a round glass flask and set it aside.

2. Ἐπὰν δὲ βούλει βάψαι σμάραγδον, λαβὼν ἰὸν χαλκοῦ καὶ ὄξος πρωτεῖον, λείωσον ἐν ἴγδῃ ὑαλίνῃ· συμμίξας καὶ χολὴν ταύρου ξηρὰν, ἢ γυπὸς, καὶ μετὰ τὸ ἑνωθῆναι ὁμοῦ, ποίησον σφαιρία, καὶ ψύξον ἐν σκιᾷ, καὶ ἔχε. Ἐπὰν οὖν μέλλῃς βάψαι λίθον, βάλε ἐκ τῶν σφαιρίων τούτων εἰς ἴγδην ὑαλίνην, καὶ λειώσας ἕνωσον αὐτῷ ἐκ τοῦ ἀνακλασταρίου, καὶ συλλειώσας, ποίησον ζωμὸν, καὶ ἔμβαλον εἰς βυσσίον ὑάλινον κεχρισμένον πυριμάχῳ πηλῷ· καὶ φέρε ἐκ τῶν κρυστάλλων οἷον βούλει σχῆμα· καὶ ἔμβαλε εἰς τὸ βυσσίον τὸ πεπηλωμένον τὸ ἔχον τὸν
ζωμόν· καὶ βαλὼν κάρβωνας, ὑπόκαιε θέρμῃ πραείᾳ· καὶ ἔασον λαβεῖν βράσμα ἕν· καὶ ἄρας ἐκ τοῦ πυρὸς, τίθει ἐν τόπῳ, καὶ ἔα ἀποβρέχεσθαι ἡμέρας γ′· καὶ ἀνελόμενος, ἔχε τῇ τοῦ Θεοῦ χάριτι.

2. Then, if you wish to dye a green stone[6], take copper rust[7] and fine vinegar, and grind in a glass mortar. Mix the dried bile of a bull or vulture, and after combining them together, form [them into] round pellets and leave them to cool in the shade and set them aside. Then, in the future, when you want to dye a stone, put some of those pellets into a glass mortar, grind them well and mix them with that [substance] from the round flask. Make a smooth wash and put it in a glass bowl coated with fire-resistant clay. Take a crystal of desired shape and put it in the coated bowl containing the wash. Set hot coals underneath it, and heat it with a low heat. Let it boil once. Then remove the fire, put it someplace and leave it to soak for 3 days. Remove it and, with the grace of God, you have it.

3. Τῇ αὐτῇ δὲ ἀγωγῇ καὶ ἐπὶ λυχνίτου, σφαιροποίησον δρακόντειον αἷμα, καὶ χυλὸν ἀγχούσης βοτάνης· καὶ συλλείωσας μετὰ τοῦ ῥηθέντος ἀνωτέρω ὕδατος τοῦ ἐν

3. In the same process for red stone[8], make round balls of dragon's blood[9] and

[6] Usually translated as "emerald," σμάραγδος more accurately refers to an entire class of green, translucent stones. I have therefore translated the term as "green stone," throughout. See Lisbet Thoresen. "Archaeogemmology and Ancient Literary Sources on Gems and Their Origins," in *Gemstones in the First Millenium AD: Mines, Trade, Workshops and Symbolism*, ed. Alexandra Hilgner, Susanne Greiff, and Dieter Quast (Mainz: Verlag des Römisch-Germanischen Zentralmuseums, 2017), 155–218.

[7] Copper rust refers to copper oxide, which assumes a greenish color.

[8] As with σμάραγδος (see n6, above), λυχνίτος also refers to a class of stones rather than a single specific stone. I have therefore translated it as "red stone" throughout.

[9] "Dragon's blood" is the name for any number of red-colored plant resins, most commonly those of the *Dracaena* plant family.

τῷ σμαράγδῳ, βάλε κρύσταλλον, καὶ βάψεις.

the juice of the alkanet plant[10] and grind it together with the aforementioned water [for the recipe] for emerald. Put in the crystal and dye [it].

4. Ὁμοίως καὶ ὑάκινθον, λαζούριον λείου σὺν χυλῷ ἰσάτεως, καὶ ποίει σφαιρία, ὡς ἀνωτέρω ἐκδέδοται· τούτου γὰρ ἄλλο κρεῖσσον οὐκ ἔστιν.

4. Similarly, for blue stone[11], grind azure with the juice of woad[12] and form it into pellets as has been described above.

5. ΤΙΝΑ ΤΑ ΕΙΔΗ ΤΥΓΧΑΝΟΥΣΙ ΤΗΣ ΤΩΝ ΛΙΘΩΝ ΚΑΤΑΒΑΦΗΣ ΚΑΙ ΠΩΣ ΟΙΚΟΝΟΜΕΙΤΑΙ. —Ἐπεὶ οὖν ἔγνωμεν ὡς τὸ συνεκτικὸν αἴτιον τῶν ἔργων τῆς τέχνης ἐστὶν ἡ κόμαρις· πρόκειται δὲ λέγειν ἡμᾶς περὶ τῆς τῶν λίθων καταβαφῆς, ἀρτίως ἴδωμεν πρῶτον τίνα τὰ βαπτικὰ εἴδη τυγχάνουσι τῶν λίθων, καὶ ὅπως ἐνωθέντα τῇ κομάρῳ, βάπτουσι κρυστάλλους ἢ τοὺς φυσικοὺς ἐπιβάπτουσι, καὶ οἷα τὰ ἀγγεῖα ἐν οἷς καὶ ὅπου οἰκονομοῦνται.

5. *What species produce the complete dyeing of stones and how [the process] is performed.* Since we know that the crucial agent in the workings of the Art[13] is *komaris*, we intend to speak concerning the deep dyeing of stones. Let us first see what are the classes of things that produce color in stones, so that having combined with *komaris*, they color crystal or intensify its natural colors, and what vessels they go in and in which way they are processed.

6. Ἐπὶ μὲν τῆς τῶν σμαράγδων ποιήσεως, καθὼς καὶ Ὀστάνει δοκεῖ τῷ πανδοχεῖ τῶν ἀρχαίων, ἰὸς χαλκοῦ, καὶ χολαὶ ζώων παντοίων, καὶ τὰ ὅμοια· ἐπὶ δὲ ὑακίνθων, ὑακίνθου πόα, καὶ ἰσάτιδος ῥίζα συνεψομένη· ἐπὶ δὲ λυχνίτου, ἄγχουσα καὶ αἷμα δρακόντειον· ἐπὶ δὲ νυκτοφανοῦς τε καὶ θαλασσοβαφοῦς ὀνομαζομένου λυχνίτου, ζώων χολαὶ θαλασσίων ἰχθυωδῶν ἢ κητωδῶν, διὰ τὸ τούτων νυκτοφανὲς, καὶ μᾶλλον γλαυκότερον, ὡς δηλοῦσιν ἔντερα καὶ λεπίδες αὐτῶν νυκτὸς ἀποστίλβοντα καὶ

7. Concerning the making of green stones, just as Ostanes[14], "the keeper of all things arcane," thinks, [the species employed are] copper rust and the bile of all sorts of animals, and things like that. For blue stones, [the species employed are] the hyacinth plant and woad root boiled together. For red stones, [the species employed are] alkanet and dragon's blood. For the red stone that is called both "night-shining" and "sea-dyed," [the species employed are] the bile of sea creatures, fish or whales, on account of

[10] *Alkana tinctoria*, commonly known as "dyer's alkanet," a red dyeing agent.

[11] As with σμάραγδος (see n6, above) and λυχνίτος (see n8, above), ὑάκινθος refers to a class of pale blue translucent stones, and I have translated it as "blue stone" throughout.

[12] *Isatis tinctoria*, commonly known as woad, a blue dyeing agent.

[13] I.e. Alchemy.

[14] The Persian sorcerer and instructor of Pseudo-Democritus, see Chapter One.

ὀστᾶ. Φησὶ γὰρ καὶ ἡ Μαρία· «Ἐὰν μὲν χλωρὸν θέλῃς, συμμάλασσε τὸν ἰὸν τοῦ χαλκοῦ μετὰ χολῆς χελώνης, ἐὰν δὲ κάλλιον βούλῃς, τῆς ἰνδικῆς χελώνης ἐπίβαλε, καὶ ἔσται πάνυ πρωτεῖον· ἐὰν δὲ μὴ εὕρῃς χολὴν χελώνης πνεύμονι θαλασσίῳ τῷ κυανέῳ χρῶ, καὶ κάλλιον ποιήσεις· συντελεσθέντες δὲ, φέγγος βάλλουσιν·

their luminescing at night, and their lustrous gleaming, as their entrails, their scales, and their bones clearly shine at night.[15] In fact, Maria[16] says, "If you should desire a pale green, melt together copper rust with the bile of a turtle. If one wants a better quality, [use that of] a turtle from India, apply [these ingredients] and [the color] will be first-rate. Should you be unable to find turtle bile, use the blue jellyfish, and you will make a very beautiful [color]. When they are completed, they give off a radiant light."

8. ὥστε τὰς μὲν χολὰς τῶν ζώων καὶ τὸν ἰὸν τοῦ χαλκοῦ Ὀστάνης, ἐπὶ τῶν σμαράγδων ἐξέλαβε, μὴ προσθεὶς τὸ θαλάσσιον· ἐπὶ ὑακίνθου δὲ, πόαν ὑάκινθον, καὶ μέλαν ἰνδικὸν, καὶ ἰσάτιδος ῥίζαν· ἐπὶ δὲ τοῦ λυχνίτου, τὴν ἄγχουσαν καὶ τὸ δρακόντειον αἷμα· ἡ δὲ Μαρία, τὸν ἰὸν τοῦ χαλκοῦ καὶ τὰς χολὰς τῶν θαλασσίων ζώων· ἐπὶ δὲ τοῦ νυκτοφανοῦς δῆλον <ὅτι> καλοῦσιν ὑάκινθον οἱ περὶ λίθων σοφοί. Διὸ καὶ προσεπάγει λέγων· «Συντελεσθέντες δὲ, φέγγος βάλλουσιν, ὡς ἀκτῖνες ἡλίου».

8. Therefore, Ostanes took the bile of animals and copper rust for green stones without adding ingredients from sea creatures. For blue stones, [he took] hyacinth plant, dark indigo[17], and woad root. For red stones, [he took] alkanet and dragon's blood. As for Maria, [she took] copper rust and the bile of sea creatures. As for the [stone that] shines at night, this is what experts in gemstones clearly call *hyacinthos*.[18] That is why she goes on saying, "When complete, they emit radiance, like the sun's rays."

9. Πόθεν οὖν λαμβάνουσι τὸ πυραυγὲς οἱ λίθοι, μήτε τῶν χολῶν, μήτε τοῦ ἰοῦ τοῦ χαλκοῦ δυναμένων αὐτοῖς τοῦτο χαρίσασθαι, χλωρῶν ὄντων ἐκ φύσεως; Τί οὖν φαμεν; Ἆρα τὴν Μαρίαν παρῆλθε τὸ τοιοῦτον χρησιμώτατον ἔργον; Αὕτη περὶ λυχνιτῶν ποιήσεως, ἣ καὶ ἀνωτέρω κατέλεξεν. Ὀστάνης δὲ τὴν ἄγχουσαν καὶ

9. But from where do the stones receive fiery-brightness? Neither bile nor copper rust have the ability to grant this [property], being green by nature. What do we say? Did such an important process elude Maria? [No!] She wrote *On the Making of Red Stones*; she also described it above. Ostanes takes alkanet and

[15] Possibly a reference to fluorite or another luminescent stone. For a discussion of this passage see Chapter Three.

[16] Maria the Jewess, discussed in Chapter One and Chapter Two.

[17] *Indigofera tinctoria*, commonly known as true indigo.

[18] Previously and subsequently in the text the stone is referred to as λυχνίτος. Here ὑάκινθον may be an error.

τὸ δρακόντειον αἷμα, καὶ ἄλλας ἑτέρων λίθων καταβαφὰς παραλαμβάνει· ὅθεν ὡς εἴδη προκαταλήξασαν τὴν ἐρυθρὰν τοῦ λίθου καταβαφὴν ἢ χροιὰν, ἥτις πυρρὰ μέν ἐστιν, ἀλλ' οὐ νυκτοφανὴς, τιμιωτέραν ἡμῖν ἐνταῦθα εἰσηγεῖται ὁ τεχνίτης ἱκανὸν εἶναι παρασκευάζειν τὸν βαπτόμενον λίθον, ἡλίου δίκην, ἀκτῖνας ἀφιέναι, νυκτὶ καὶ δύνασθαι τοὺς κεκτημένους ἀναγινώσκειν καὶ γράφειν καὶ πάντα πράττειν, σχεδὸν ὡς ἐν ἡμέρᾳ· τὸ μὲν γὰρ θεωρεῖσθαι νυκτὸς ἕκαστος ἔχει λυχνίτης, κατὰ τὸ οἰκεῖον μέγεθος καὶ τὴν καθαρότητα φυσικὸν ἢ τεχνικόν· τὸ δὲ φωτὸς εἶναι χορηγὸν μόνον ἴδιόν τε καὶ ἐξαίρετον τοῦ νυκτοφανοῦς· ἡ γὰρ λέξις ἐνταῦθα, οὔτε ἡμέρᾳ φαινόμενον ὑπαινίττεται μόνον, ἀλλὰ τὸν νυκτὸς φαίνοντα δείκνυσιν.

dragon's blood and other different dyes for other stones, from which point, on the grounds that he had already recounted that the red dye or the color of the stone which is fiery red but not luminescent, is more precious to us, the artisan explains that it is sufficient to prepare the dyed stone to give off rays like the sun at night, and [he explains that by its light] those possessing it can read and write and do everything else, almost as they could during the day. Each red stone has the property of being seen at night according to its particular size and clarity, be it natural or artificial. But the property of emitting light uniquely belongs to the night-shining red stone. For the term[19] here does not indicate only that which shines during the day, but that which demonstrates shining at night.

10. Αἱ μέντοι χολαὶ τῶν ζώων ἀποστάξασαι τὸ ὑδατῶδες σκιόψυκτοι γίνονται, καὶ οὕτω πρόκεινται τῷ ἰῷ τοῦ ἡμετέρου χαλκοῦ, τουτέστι τῇ κομάρῳ, καὶ ἕψονται ἅμα τεχνικῶς καὶ χρωσθεῖσαι τῷ ὕδατι, ἄφευκτοι γίνονται· καὶ σειρωθέντος τοῦ ὕδατος, θερμαίνονται οἱ λίθοι καὶ χαλῶνται θερμοὶ ἐν τῷ βάμματι, κατὰ τὴν Ἑβραίων φωνήν. Εἰ μέντοι τὸ χολῶδες χρῶμα μεῖόν ἐστι δυνατὸν τῷ λίθῳ πολλὴν ἐμποιῆσαι χλωρότητα, βάλλεται σὺν τῷ ἡμετέρῳ ἰῷ καὶ ὁ κοινὸς ἰὸς χαλκοῦ καὶ χαλκάνθης ὀλίγης, καὶ ὅσα ἕτερα δύνανται βοηθῆσαι τοῖς ἐπιβαπτομένοις ἢ πλαττομένοις λίθοις, καὶ μάλιστα τοῖς σμαράγδοις.

10. Then the water of the animal bile is boiled off, and they are left to cool. And in this way they are combined with our copper rust, that is to say with *komaris*.[20] Then they are boiled together according to the instructions of the art, and after being colored by the water, they are ready for dyeing. And after the water has been heated, the stones are heated, and while still hot, they are eased into the dye, according to the sayings of the Hebrews.[21] Nevertheless, if the bile color has little ability to produce sufficient green-ness in the stone, our rust is also supplemented with the common rust of copper, and a little blue vitriol, in addition to whatever else can help in dyed or fabricated stones, especially green stones.

[19] I.e., νυκτοφανὲς.

[20] Here *komaris* is equated with copper oxide.

[21] Another reference to Maria the Jewess.

11. Ἰστέον δὲ ὅτι αἱ χολαὶ τῶν θαλλαττίων ζώων λαμπηδόνα συμβάλλονται πρὸς ἑκάστου λίθου καταβαφὴν, συμμέτρως παραλαμβανόμεναι μετὰ τῶν ἁρμοζόντων ἑκάστῳ χρώματι ζωγραφικῶν, ἢ ἄλλων τινῶν εἰδῶν. Χρὴ δὲ γενέσθαι πᾶσαν βαφὴν ἐν ὑαλίνοις ποτηρίοις λαμπροῖς, καὶ πάντα ποιεῖν, μετὰ τοῦ καθολικοῦ κανόνος, τοῦτο ὡς ἐπινοεῖς· οὐ γὰρ ἀμελητέον αὐτῶν.

11. One must know that the bile of sea creatures contributes brilliance to the dyeing of each stone taken proportionally with the paints that correspond to each color, or some other such things. It is necessary to have made all the dye in clean glass vessels, and to make all in accordance with the proper standard, as you conceive it. These [stipulations] must not be neglected.

12. ΤΙΣ Ο ΤΗΣ ΟΨΕΩΣ ΤΩΝ ΧΡΩΜΑΤΩΝ ΗΤΟΙ ΠΟΙΗΣΕΩΣ ΤΡΟΠΟΣ
ΤΩΝ ΒΑΠΤΟΜΕΝΩΝ ΛΙΘΩΝ. — Διδάσκων ἡμᾶς ὁ φιλόσοφος τίς ὁ τῆς ὄψεως τρόπος τῶν χρώματι ὄντων βαπτομένων λίθων ἐστὶν, ἐν τῷ περὶ λίθων καταθέτῳ χαλκοῦ, οὕτως φησί· «Ἔστιν, ὡς ἤκουσα ἐν τῷ πατροπαραδότῳ βιβλίῳ, χολὴ ἰχνεύμονος, χολὴ γυπεία· ἐν ταύταις ταῖς χολαῖς, ὅστις ἂν δυνηθῇ τὸν ἰὸν τοῦ χαλκοῦ σῆψαι ἡμέρας μ′, ἵνα, τῆς ὕλης σαπείσης, γένηται ἡ θέσις τῶν λίθων, καὶ ἀμετάτρεπτος ὁ ἰὸς τὸ εἶδος φυλάξῃ, κατὰ τὸν Ἀγαθοδαίμονα· περὶ οὗ καὶ ὁ θεσπέσιος λέγει Μωϋσῆς ὁ προφήτης ἐν τῇ οἰκείᾳ χυμευτικῇ τάξει· «Καὶ πάντα βαλὼν ἐν σφαιρίῳ ὑαλουργικῷ, ἕψει, ἕως γένηται κινναβαρῶδες, καὶ τελέσῃ τὸ θεοδώρητον μυστήριον.» Ὅτι δὲ τὴν ἀσινῆ καὶ σύμμετρον ἠνίξατο τοῦ συνθέματος θέρμην, διὰ τῆς τοῦ ἡλίου προσηγορίας, δείκνυσι σαφῶς, καὶ διὰ τῆς ἐπιστολῆς τῆς διὰ τῶν ἰάμβων πρὸς τὴν Σάνην, λέγων ἀναφανδόν·

καὶ πάντ’ εἰσάξεις ὡς εἰς ἥλιον σφοδρόν.

12. *How to manifest or produce the colors of dyed stones*:
The philosopher, teaching us how to manifest the colors of the dyed stones by the setting of iron rust on stones, says the following, “It is, as I heard in the book handed down from my predecessor, bile of an Egyptian mongoose, bile of a vulture. These biles – whoever can ferment copper rust within them for forty days, so that, after the material has fermented, the stones are placed in it, and the rust keeps the appearance unchanging, as Agathodaimon attests.[22] Concerning this the divine prophet Moses says in his own alchemical treatise, “Put everything in a round glass furnace, melt it, until it becomes like cinnabar, and completes the God-given mystery.” That he spoke figuratively of the safe and proportional heating of the mixture, he makes abundantly clear through his reference to the sun and through his letter [composed] in iambs to Sane, saying the following openly, “and you will bring everything as if in a strong sun.”[23]

[22] Agathodaimon is a mythical figure mentioned multiple times in the alchemical corpus.

[23] While an operation attributed to Moses exists in the alchemical corpus, this letter to Sane, an unidentified recipient, is presumed lost.

13. ΠΕΡΙ ΧΥΜΕΥΤΙΚΗΣ: Λαβὼν σηρικὸν λίτρας γ′, κρύσταλλον καθαρὸν λίτραν α′, κασσίτερον ἑξάγια β′, λείωσον θεῖα ὡς χοῦν· καὶ βάλε αὐτὰ εἰς χυτρίδιον ἄθικτον, καὶ παρόπτα αὐτὰ εἰς κάρβωνα, ἕως γένηται ὕαλος πράσινος. Ἐὰν ὑπάρχῃ τὸ πῦρ ἐκτεταμένον, γίνεται χρυσοειδές· εἰ δὲ ἐπὶ πλέον, λευκὸν ὥσπερ κρύσταλλος.

13. *On Enameling*:[24] Take 3 liters of *syrikon,* 1 liter of clear glass, 2 *hexagia*[25] of tin, and grind approximately one *chous*[26] of sulfur into a fine powder. Put them in a clean small cup, and heat them over the charcoal until it becomes green glass. If the heating is extended it becomes golden; if extended even longer, white like crystal.

[24] I have translated χυμευτικῇ here as enameling in the context of the entire recipe. For a discussion of this passage, see Chapter Three.

[25] Approximately 10.2 grams.

[26] A unit of measurement equivalent to 12 *kotylae*, approximately 3.2 liters.

Figure 1. Hinged closure representing the Virgin Mary and Christ, cloisonné enamel on gold, ca. tenth – eleventh century, Dumbarton Oaks Collection, Washington, D.C. Image Credit: Author.

Figure 2. Hinged closure representing the Virgin Mary and Christ, cloisonné enamel on gold, ca. tenth – eleventh century, Dumbarton Oaks Collection, Washington, D.C. Image Credit: Author.

Figure 3. Plaque representing Saint Peter, cloisonné enamel on gold, ca. eleventh century, The Metropolitan Museum of Art, New York. Image in Public Domain (The Metropolitan Museum of Art).

Figure 4. Revetment for an icon of the Virgin Mary, champlevé enamel on gilded silver, ca. thirteenth century, Treasury of San Marco, Venice.
Image Credit: Meraviglie di Venezia.

Figure 5. Pendent reliquary of Saint George and Saint Demetrios, cloisonné enamel on gold, ca. eleventh century, The British Museum, London.
Image in Public Domain (The British Museum).

Figure 6. Three plaques from a crown representing *senmurvs* and the Ascension of Alexander the Great from the Preslav Treasure, cloisonné enamel on gold, ca. 927, Archaeological Museum Veliki Preslav, Preslav.
Image Credit: Author.

Figure 7. Medallion representing the Archangel Michael, cloisonné enamel on gold, ca. eleventh century, Musée du Louvre, Paris.
Image Credit: Musée du Louvre.

Figure 8. Dress ornament, “filigree” enamel on gold, ca. nineteenth century,
The Walters Art Museum, Baltimore.
Image in Public Domain (The Walters Art Museum).

Figure 9. Reliquary cross of Pope Paschal I, cloisonné enamel on gold, gilded copper, ca. first quarter of the ninth century, Vatican Museums, Rome.
Image Credit: Vatican Museums.

Figure 10. The Beresford-Hope Cross, cloisonné enamel on gold, gilded silver, ca. ninth century, The Victoria and Albert Museum, London.
Image Credit: The Victoria and Albert Museum.

Figure 11. Cross with birds and *Zoe-Phos*, "filigree" enamel on gold, ca. sixth – seventh century, Dumbarton Oaks Collection, Washington, D.C.
Image Credit: Dumbarton Oaks Collection.

Figure 12. Alchemical notations and apparatus, Biblioteca Marciana gr. 299, f. 188v., tenth – eleventh century, Biblioteca Marciana, Venice.
Image in Public Domain (Wikimedia Commons).

Figure 13. Anonymous text with *ouroboros*. Paris gr. 2327 f. 279r., 1478, Bibliothèque nationale de France, Paris.
Image in Public Domain (Wikimedia Commons).

Figure 14. Calyx. Blood jasper (heliotrope) and gilded copper.
ca. tenth – eleventh century, The Cleveland Museum of Art, Cleveland.
Image in Public Domain (The Cleveland Museum of Art).

Figure 15. Cameo representing the bust of Christ, glass paste, ca. eleventh – thirteenth century, The British Museum, London.
Image in Public Domain (The British Museum).

Figure 16. Cameo representing the Virgin and Child enthroned with angels, detail view, chalcedony, ca. eleventh – twelfth century, The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 17. *Artophorion* (Reliquary of St. Anastasios the Persian), gilded silver and niello, ca. 969 – 970, Aachener Dom Schatzkammer, Aachen;
Image Credit: Bagnoli, ed. 43.

Figure 18. *Artophorion* (Reliquary of St. Anastasios the Persian), detail;
Image Credit: Author.

Figure 19. The Fieschi-Morgan *Staurothēkē*. Cloisonné enamel on gold, gilded silver, and niello, ca. ninth century, The Metropolitan Museum of Art, New York. Image in Public Domain (The Metropolitan Museum of Art).

Figure 20. The Fieschi-Morgan *Staurothēkē*, detail of lid;
Image in Public Domain (The Metropolitan Museum of Art).

Figure 21. The Fieschi-Morgan *Staurothēkē*, detail of sides;
Image in Public Domain (Wikimedia Commons).

Figure 22. The Fieschi-Morgan *Staurothēkē*, view of lid interior;
Image in Public Domain (The Metropolitan Museum of Art).

Figure 23. Furnaces attributed to the invention of Maria the Jewess as quoted in the works of Zosimos of Panopolis, Paris gr. 2327 fol. 221v.,
Bibliothèque nationale de France, Paris.
Image in Public Domain (Wikimedia Commons).

Figure 24. Cloisonné enamel test plate showing color change before and after firing; Image Credit: Author.

Figure 25. Inlaid columns from the church of Hagios Polyeuktos, marble, amethyst, and glass, ca. 520, Istanbul Archaeology Museum, Istanbul.
Image in Public Domain (Wikimedia Commons).

Figure 26. Emperor Justinian I with Bishop Maximian and courtiers, mosaic, ca. 547, Basilica of San Vitale, Ravenna.
Image in Public Domain (Wikimedia Commons).

Figure 27. Pectoral cross from Martvili, cloisonné enamel on gold, pearls, and precious stones, ca. tenth – eleventh century, Georgian State Museum of Fine Arts, Tbilisi; Image Credit: Xuskivadze, 27.

Figure 28. Reliquary cross, cloisonné enamel on gold ca. tenth – eleventh century,
The British Museum, London;
Image in Public Domain (The British Museum).

Figure 29. Pectoral cross representing Constantine, Helena, and Prophets now incorporated into the Khakhuli Triptych, cloisonné enamel on gold, ca. tenth – eleventh century, Georgian State Museum of Fine Arts, Tbilisi;
Image Credit: Xuskivadze, 36.

Figure 30. Pectoral cross from Martvili, detail;
Image Credit: Xuskivadze, 28.

Figure 31. Pectoral cross from Martvili, detail;
Image Credit: Xuskivadze, 28.

Figure 32. Pectoral cross from Martvili, detail;
Image Credit: Xuskivadze, 28.

Figure 33. Pectoral cross from Martvili, detail;
Image Credit: Xuskivadze, 28.

Figure 34. The Stoclet paten, cloisonné enamel on gold, gilded silver, agate, and precious stones, ca. ninth to tenth century, Musée du Louvre, Paris.
Image Credit: Evans and Wixom, 67.

Figure 35. The Stoclet paten, detail of Last Supper;
Image Credit: Musée du Louvre.

Figure 36. Engraved gem with Christ Emmanuel, rock crystal and blue glass, ca. sixth – seventh century, Dumbarton Oaks Collection, Washington, DC. Image Credit: Genevra Kornbluth.

Figure 37. Earrings, gold and blue glass, ca. eighth – ninth century,
Byzantine and Christian Museum, Athens;
Image in Public Domain (Wikimedia Commons).

Figure 38. Earring or diadem ornament, gold, pearls, precious stones, and green glass, ca. tenth century, National Archaeological Museum, Athens.
Image Credit: Bosselmann-Ruickbie, 239.

Figure 39. *Perikarpia*, cloisonné enamel on gold, gold, ca. tenth century, Museum of Byzantine Culture, Thessaloniki.
Image Credit: Museum of Byzantine Culture.

Figure 40. *Perikarpia*, detail;
Image Credit: Author.

Figure 41. The Martvili Triptych, cloisonné enamel on gold, gilded silver, precious stones, and pearls, ca. ninth – tenth century, State Museum of Fine Arts, Tbilisi. Image Credit: Xuskivadze, 28.

Figure 42. Medallions representing the Virgin and Saint Theodore from the Khakhuli Triptych, cloisonné enamel on gold, ca. ninth – tenth century,
State Museum of Fine Arts, Tbilisi.
Image Credit: Xuskivadze, 27.

Figure 43. Votive crown of Leo VI, cloisonné enamel on gold, gilded silver, pearls, precious stones, ca. 886-912, Tesoro di San Marco, Venice.
Image Credit: Buckton, ed. (1984), 121.

Figure 44. Chalice of the Emperor Romanos, cloisonné enamel on gold, gilded silver, sardonyx, and pearls, ca. tenth century, Tesoro di San Marco, Venice.
Image Credit: Meraviglie di Venezia.

Figure 45. Chalice of the Patriarchs, cloisonné enamel on gold, gilded silver, sardonyx, pearls, and rock crystal, ca. tenth century, Tesoro di San Marco, Venice.
Image Credit: Meraviglie di Venezia.

Figure 46. Limburg *Staurothēkē*, view of lid. Cloisonné enamel on gold, gilded silver, precious stones, and pearls, ca. 963 – 985,
Diözesanmuseum Limburg, Limburg an der Lahn.
Image in Public Domain (Wikimedia Commons).

Figure 47. Limburg *Staurothēkē*, view of interior;
Image in Public Domain (Wikimedia Commons).

Figure 48. Limburg *Staurothēkē*, detail of lid;
Image in Public Domain (Wikimedia Commons).

Figure 49. Limburg *Staurothēkē,* detail of lid;
Image Credit: Diözesanmuseum Limburg.

Figure 50. Plaque representing Saint Demetrios, cloisonné enamel on gold, ca. tenth century, Dumbarton Oaks Collection, Washington, D.C.
Image Credit: Author.

Figure 51. Double-sided pendant, cloisonné enamel on gold, ca. 1100,
The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 52. Tip of a pointer, cloisonné enamel on gold, ca. eleventh – twelfth century, The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 53. Tip of a pointer, cloisonné enamel on gold, ca. eleventh – twelfth century, The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 54. Temple pendant, cloisonné enamel on gold, ca. eleventh – twelfth century, The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 55. Plaque representing the Crucifixion, cloisonné enamel on gold, ca. eleventh century, Wittelsbacher Ausgleichsfonds, Munich.
Image Credit: Wittelsbacher Ausgleichsfonds.

Figure 56. The Pala d'Oro, cloisonné enamel on gold, gilded silver, precious stones, and pearls, current form ca. 1345, Basilica di San Marco, Venice.
Image in Public Domain (Wikimedia Commons).

Figure 57. Plaque representing the *Anastasis*, from the Pala d'Oro, cloisonné enamel on gold, ca. twelfth century, Basilica di San Marco, Venice.
Image Credit: Volbach et. al. Table XLV.

Figure 58. Plaque representing the Entry into Jerusalem, from the Pala d'Oro, cloisonné enamel on gold, ca. twelfth century, Basilica di San Marco, Venice. Image Credit: Volbach et. al. Table XLIII.

Figure 59. Plaque representing the *Koimesis*, from the Pala d'Oro, cloisonné enamel on gold, ca. twelfth century, Basilica di San Marco, Venice.
Image Credit: Volbach et. al. Table XLVII.

Figure 60. Holy Crown of Hungary, cloisonné enamel on gold, pearls, and precious stones, Byzantine enamel plaques ca. 1074 – 1077, Hungarian Parliament, Budapest. Image in Public Domain (Wikimedia Commons).

Figure 61. Holy Crown of Hungary, detail of Archangel Michael.
Image in Public Domain (Wikimedia Commons).

Figure 62. Holy Crown of Hungary, detail of Géza I of Hungary.
Image in Public Domain (Wikimedia Commons).

Figure 63. Plaque representing Emperor Michael VII Doukas and his wife Maria of Alania, from the Khakhuli triptych, cloisonné enamel on gold, ca. 1071 – 1078, State Museum of Fine Arts, Tbilisi.
Image Credit: Xuskivadze, 42.

Figure 64. Panels from a cover for an icon of the Virgin, cloisonné enamel on gold, ca. twelfth century, The Metropolitan Museum of Art, New York.
Image in Public Domain (The Metropolitan Museum of Art).

Figure 65. Panel from a cover for an icon of the Virgin, detail;
Image in Public Domain (The Metropolitan Museum of Art).

Figure 66. Panel from a cover for an icon of the Virgin, detail;
Image in Public Domain (The Metropolitan Museum of Art).

Figure 67. Icon of the Archangel Michael, cloisonné enamel on gold, gilded silver, and precious stones, ca. eleventh century, Tesoro di San Marco, Venice.
Image Credit: Brad Hostetler.

Figure 68. Icon of the Archangel Michael, detail.
Image Credit: Meraviglie di Venezia.

Figure 69. Icon of the Archangel Michael, detail
Image Credit: Author.

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