

The Secrets of
ALCHEMY



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❁ INTRODUCTION ❁

WHAT IS ALCHEMY?

Although alchemy's glory days came to an end roughly three centuries ago, the Noble Art endures in many ways. The very word *alchemy* conjures up vivid images of the hidden, the mysterious, and the arcane, of dark laboratories and wizard-like figures bent over glowing fires and bubbling cauldrons. Today, most people have heard something about the Philosophers' Stone, the substance capable of turning lead into gold that was so eagerly sought by legions of alchemists. Indeed, an entire generation became acquainted with the stone and one of its supposed possessors, the medieval Parisian notary Nicolas Flamel, by means of the first of J. K. Rowling's wildly successful books: *Harry Potter and the Philosopher's Stone*. (Regrettably, American publishers corrupted the substance's ancient name into the meaningless "Sorcerer's Stone." Alchemy has not always gotten the respect it deserves.) The sixteenth-century Swiss alchemist Theophrastus von Hohenheim, better known as Paracelsus, recently found new life as "Hohenheim of Light" in the Japanese manga and anime series *Fullmetal Alchemist*, which makes copious if highly sensationalized use of alchemical concepts. Trading on the link

between alchemy and transformation, many modern books have *alchemy* in their title, thereby renewing alchemy's modern presence virtually every year. Such titles range from Paul Coelho's 1988 best-selling novel *The Alchemist* to more trite borrowings of the term as *The Alchemy of Love* and *The Alchemy of Finance*, to the more imaginative *American Alchemy: The History of Solid Waste Management in the United States*. The alchemical theme of transformation is also responsible for the frequent appearance of the term in various self-help programs.

Besides these manifestations of variously transformed versions of alchemy, a perhaps surprising number of people throughout the world are continuing to search for practical metallic transmutation, despite rather discouraging prognostications from modern chemistry, often more or less in the same ways it was pursued centuries ago. Some such modern seekers—I know from personal experience—even hold positions in university departments. Alchemy thus continues to exist in a variety of guises and disguises.

But much of the modern world's familiarity with alchemy is more apparent than real. While the mystique of the subject naturally attracts interest, its inherent difficulty and complexity easily deflect attempts to understand it. Arriving at solid, satisfactory conclusions about alchemy can seem as difficult as finding the Philosophers' Stone itself. Alchemy's primary sources present a forbidding tangle of intentional secrecy, bizarre language, obscure ideas, and strange imagery. The alchemists did not make it easy for others to understand what they were doing. Secondary sources about alchemy, whether books or websites, are frequently even more problematic, for they soon plunge the reader into a maze of conflicting claims and contradictory assertions. The historically informed works readily available today range from excellent scholarly publications (which naturally presuppose considerable expertise) to introductory but now outdated overviews.¹ Far outnumbering works by historians, however, are those by an assortment of popular writers, occultists, enthusiasts, and a few hucksters that recapitulate a variety of clichés, misconceptions, historical errors, and baseless opinions, rather than presenting the current state of knowledge about the subject. Most such books link alchemy in various ways—both favorable and unfavorable—to religion, psychology, magic, theosophy, yoga, the New Age movement, and, perhaps most often, to loosely defined notions of the "occult." Without guidance, it thus proves extremely difficult for even

the most intrepid seeker to emerge from such a labyrinth with any clear or sound conclusions about the true nature of alchemy.

So what *is* alchemy? Who were the alchemists, and what did they believe and do? What were their goals, and what did they accomplish? How did they envision their world and their work, and how were they seen by contemporaries? These are the main questions I explore in the following pages.

My goal is to provide a reliable guide to the various secrets of alchemy. A comprehensive history of the subject not only would run to unreadable length but also would be premature, since scholars still have much to learn about it. I present instead only an introduction that can serve as a solid foundation for further inquiry. My chief motivation, then, in writing this book has been to make some of the enormous wealth of recent discoveries about alchemy accessible to a wider audience. While alchemy has always been considered secret and privileged knowledge, perhaps the best-kept alchemical secret of our day is how radically our understanding of the subject has changed during the last forty years. Alchemy is now a hot topic among historians of science. Books and manuscripts that have lain unread for centuries are now being read again, and their contents more accurately understood in historical context. We are learning more about alchemy every day. Yet much of this new information has remained inaccessible to most readers, because it is published in specialist literature and in multiple languages—more often than not in languages other than English. The result has been that most popular writing about alchemy repeats the same mistaken notions over and over again, perpetuating errors that were satisfactorily and convincingly corrected in the scholarly literature as much as eighty years ago. I believe that interested readers deserve much better.

I wrote *The Secrets of Alchemy* to function on two levels. In the main body of the text, I keep the nonspecialist, the general reader, and the student in mind. No prior knowledge of alchemy or specialized knowledge of the history of science is necessary to understand it. Some familiarity with chemistry will help in chapter 6, but is not crucial. For readers who want to delve more deeply into one or more aspects of the subject, however, I have supplied extensive endnotes directing them to more advanced treatments. These notes are intended to function as a categorized (but not exhaustive) guide to the most reliable current scholarship on the subject as well as to sound editions of primary texts. I have not

been so pedantic as to list *every* source available on each topic; I have instead chosen only the best and most pertinent. My apologies to scholars whose relevant works I have not yet encountered; I would be delighted to receive references or offprints.

I have strenuously avoided making this book a *Who's Who* of alchemy. Many practitioners of the discipline, including some important ones, receive only passing mention or even none at all—a fact that might disappoint some readers. I chose instead to focus on a small number of important characters, each of whom represents a major trend or feature within alchemy. Readers will thus gain a deeper familiarity with the thinking of a few foundational figures who can act as reckoning points within the long alchemical tradition, rather than coming away with a superficial overview of many characters.

Alchemy's Periodization and the Structure of This Book

Historians of science customarily divide the history of Western alchemy into three main chronological periods: the Greco-Egyptian, the Arabic, and the Latin European. The Greco-Egyptian (and later, Byzantine) period, which stretches from the third to the ninth century, set alchemy's foundations and established many features that would characterize it for the remainder of its life. The Arabic or Islamic period (eighth to fifteenth century) sought out this Greek heritage and then massively augmented it with fundamental theoretical frameworks and a wealth of practical knowledge and techniques. Thus when alchemy arrived in medieval Europe, it came as an Arabic science, its lineage signaled by the Arabic definite article *al-* affixed to the word itself. It was thereafter in Europe that alchemy saw its greatest flowering and largest following. After its establishment in the High Middle Ages (twelfth to fifteenth century), alchemy achieved its golden age during the early modern period (sixteenth to early eighteenth century), an era widely known as the Scientific Revolution. Not only was the alchemy of this period the most developed and diverse of all, but we possess vastly more sources dating from this time than from earlier ones.

To these three eras of the standard periodization should be added a fourth, which stretches from the eighteenth century to the present day. It is to this (ongoing) period that we owe influential “revivals” and radical

reinterpretations of earlier alchemical traditions, several of which generated lively cultural and intellectual movements of their own. This period should be treated as a significant part of the full history of alchemy. It is also to this period that we owe most of the misconceptions about pre-eighteenth-century alchemy that remain widespread. Consequently, it is better to examine the origins of these depictions of alchemy, and to situate them in their due historical contexts, so that they do not distract from our efforts to gain a more historically accurate depiction of alchemy as it existed before the eighteenth century. To that end, revealing the surprising (and surprisingly late) origins of many ideas about alchemy widely held today is sufficiently important to warrant violating chronological order. Therefore, chapters 1 through 3 cover Greco-Egyptian, Arabic, and medieval Latin alchemy, respectively, but chapter 4 jumps over alchemy's golden age of the sixteenth and seventeenth centuries to treat the eighteenth-century "end" of alchemy and the subsequent era of reinterpretations and revivals. Chapter 5 resumes the chronological sequence by exploring alchemy in the early modern period.

Topics akin to those pursued in Western alchemy were also subjects of early inquiry further East—that is to say, in India and China. However, the Indian and Chinese material is not covered here. The major reason is simply that we do not yet have a sufficiently comprehensive or accurate understanding of it. Furthermore, when previous treatments of alchemy attempted to combine Eastern and Western alchemy into a single narrative, the result was usually more confusion, not greater clarity. For example, an ahistorical conflation of Chinese and Western alchemy spawned the popular, but erroneous, notion that European alchemists sought an "elixir of immortality." Although Western practitioners did seek medicines that would *extend* life, the search for earthly immortality through alchemy was a uniquely Chinese goal. Eastern and Western pursuits and practices do bear certain resemblances, but they are embedded in such widely divergent cultural and philosophical contexts that trying to squeeze them into a single narrative damages the uniqueness of each one. The Western term *alchemy* might even prove to be a misleading label for the Eastern practices known more correctly as *waidan* and *neidan*. In any event, meaningful historical linkages between Eastern "alchemy" and Western alchemy remain unidentified (although contact within the Islamic world is certainly plausible), and so it is unwise to

assume or assert such linkages in the current absence of clear and compelling historical evidence. The two “alchemies” of East and West are, at least at this point in time, better treated as separate entities.²

The last three chapters of this book recount aspects of alchemy’s great flowering in sixteenth- and seventeenth-century Europe. Chapter 5 gives an overview of early modern alchemical theory and practice, and outlines its terminology and goals in making metals, medicines, and other arcana. Chapter 6 confronts the difficult question of what alchemists were actually doing in their laboratories. I approach this question by two complementary routes: the textual and the experimental. The first and more traditional route involves deciphering the bizarre language and imagery that early modern alchemists routinely used to conceal their knowledge and activities. The second and more novel route involves replicating the deciphered alchemical processes in a modern laboratory to see and do what early modern alchemists saw and did, and to test the correctness of the textual interpretations. Chapter 6 both explains step by step how to understand enigmatic texts and images purporting to teach the preparation of the Philosophers’ Stone, and reveals the actual chemical basis for the secretly encoded processes. The results are often very surprising.

Alchemy’s place in early modern Europe extended far beyond the confines of smoky laboratories; it diffused itself through a wide swath of contemporaneous culture. Artists, poets, humanists, playwrights, devotional writers, theologians, and many others borrowed from and commented on alchemy. Their works offer additional perspectives on the Noble Art. Additionally, some ways of thinking natural to alchemists illustrate profound differences between the ways early modern people saw and thought about their world and the ways we (or at least most of us) do today. The study of alchemy therefore opens a window onto a remarkable and meaning-rich vision of the world that has largely been lost today. This vision was by no means unique to alchemists; it was common throughout European culture of the day. Failing to understand that vision means failing to understand not only alchemy but our predecessors as a whole, and indeed diminishing ourselves by allowing a crucial part of Western heritage to fall into oblivion. The seventh and final chapter presents these wider worlds of alchemy.

The study of alchemy—and of the past in general—brings us into contact with the diverse ways thinkers of other times and cultures conceived of the world, how they answered questions the world posed to them, and

how they made use of the powers and riches of that world. This why we study history: to see, at least for a time, with the eyes of others, and to be enlightened and enriched by the fresh (but ancient) ways they might see even the most common and neglected of things. In this regard, alchemy still has much to teach.

ORIGINS

Greco-Egyptian *Chemeia*

To locate the origins of alchemy, we must travel back to Egypt in the first centuries of the Christian Era. This place was no longer the Egypt of the far more ancient pharaohs and pyramid builders but a cosmopolitan, Hellenized civilization. Egypt had come under the influence of Greek culture following its conquest by Alexander the Great during his vast military campaigns of 334–323 BC. Even after Egypt's absorption into the Roman Empire in the first century BC, its dominant culture and language remained Greek. By the first century AD, its major city, Alexandria (founded in 331 BC and named for Alexander himself), had become a vibrant crossroads for cultures, peoples, and ideas. From this Eastern Mediterranean melting pot, the earliest surviving chemical texts, and even the origin of the word *chemistry* itself, date.

Many technical operations fundamental for alchemy had been developed well before its emergence. The smelting of metals such as silver, tin, copper, and lead from their ores had been practiced already for four thousand years. The making of alloys (such as bronze and brass, both

alloys of copper) and various techniques for metallurgy and metalworking had been developed to a fairly high degree. In Egypt, artisans had devised an array of processes for making and working glass, producing artificial gems, compounding cosmetics, and creating many other commercial products in what might be called an ancient chemical industry.¹ Generations of workshop laborers had devised and refined these techniques, with the tricks of the trade passed down from father to son, from master to apprentice.

The Technical Literature: The Papyri and Pseudo-Democritus

The earliest documents that scholars routinely attach to the history of alchemy bear witness to this technological and commercial background. These precious and unique texts, written in Greek on papyrus, date from the third century AD. They were discovered in Egypt in the early nineteenth century and now reside in museums in Leiden and Stockholm; hence they are called the Leiden and Stockholm Papyri.² They contain about 250 practical workshop recipes. These recipes fall into four chief categories: processes relating to gold, to silver, to precious stones, and to textile dyes, all costly articles of luxury and commerce. Significantly, most of the recipes deal with how to make *imitations* of these valuable substances: coloring silver to look like gold, or copper to look like silver; making artificial pearls and emeralds; and coloring cloth purple using cheaper imitations of the extravagantly expensive imperial purple dye made from murex snails. Since the Papyri also contain a series of tests to determine the purity of various metals, both precious and common, it is evident that the original users of these formulas clearly understood the difference between genuine and imitation articles.

We can get a better sense of what these craftsmen were doing by trying to follow in their footsteps. The eighty-seventh recipe in the Leiden Papyrus describes the “discovery of the water of sulfur.” The ancient text’s directions are these: “Lime, one dram; sulfur, previously ground, an equal quantity. Put them together into a vessel. Add sharp vinegar or the urine of a youth; heat from underneath until the liquid looks like blood. Filter it from the sediments, and use it pure.”³ The ingredients of this recipe are simple, clearly identifiable, and readily obtainable, so we can replicate the process today. After the ingredients are mixed (I found that urine works better than vinegar, by the way) and boiled gently for

about an hour, an orange-red and unpleasantly scented liquid results. Although the Leiden Papyrus does not say *how* to use the liquid, we can guess. When a polished piece of silver is dipped into it, the metal quickly becomes tawny, then golden, then coppery, then bronzy, purple, and finally brown. Impressively, the shiny brilliance of the metal remains undiminished by the color changes until the very end, and the color and sheen remain stable for long periods of time. With a little practice and careful control of the temperature and the length of time the metal is left in the solution, I succeeded in making silver look astonishingly like gold (see plate 1).⁴

The color changes result from the formation of extremely thin layers of sulfides on the metal surface, owing to the action of calcium polysulfides present in this “water of sulfur.” To be sure, similar compositions are still used occasionally today for patinating metal objects (in other words, producing changes to their surface color).

Recipes such as this one provide a necessary background to the emergence of alchemy, but they are not themselves, strictly speaking, alchemical. Alchemy, like other scientific pursuits, is more than a collection of recipes. There must also exist some body of theory that provides an intellectual framework, that undergirds and explains practical work, and that guides pathways for the discovery of new knowledge. Alchemy moreover was to be about more than making look-alikes of precious substances.

It is important to realize that these papyri are the *only* original documents currently known to survive from the Greco-Egyptian period. Despite the many books about alchemy that we know were written during that time, the only surviving testimony of that distant era comes in the form of corrupt anthologies—that is, collections of excerpts copied from original texts that are now lost. These anthologies—collectively called the *Corpus alchemicum graecum*—were compiled by Byzantine scribes, and the earliest of them dates from a time long after Greco-Roman Egypt had itself become a faded memory. The oldest surviving copy dates from around the start of the eleventh century, and many of its pages are missing. It contains excerpts from about two dozen books dating from the second to the eighth century, and is now preserved in Venice. This manuscript, called Marcianus graecus 299, is supplemented by a few later manuscripts now in Paris and elsewhere that contain additional texts or alternate readings. While priceless to scholars, these

collections represent only a frustratingly slim remainder of alchemy's foundational epoch.⁵ 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. Hence, the overall picture of what Greco-Egyptian alchemists thought and did is skewed by the way their writings were excerpted centuries later.

The earliest text within the *Corpus alchemicum graecum* dates from about the late first or second century AD. It carries the title *Physika kai mystika*, and the text we possess is fragmentary. Its author is named as Democritus; but he is certainly not, as is sometimes claimed, the ancient philosopher of the fifth century BC famous for his notion of atoms.⁶ The title, which may have been given to it much later, is often translated as *Physical and Mystical Things*. Although that might *look* like a reasonable rendering of the Greek, it is misleading. A better translation is *Natural and Secret Things*. The Greek word *mystika* did not refer in ancient times to what we today call mystical, that is, something having a special religious or spiritual meaning, or expressing a personal experience of the ineffable. Instead, it simply meant things to be kept secret.⁷ Calling this text *Physical and Mystical Things* immediately suggests that the author was describing both material and spiritual things, but this is not the case. The *Physika kai mystika* records workshop recipes similar to those of the Leiden and Stockholm Papyri. In fact, it uses the same fourfold division of processes into those for gold, silver, gems, and dyes. This similarity of format suggests that a whole tradition of practical recipe books once existed in which this division was standard. For pseudo-Democritus, these processes are *mystika*, that is, *secret*, because they are lucrative artisanal processes—trade secrets, if you will.

Nevertheless, the text also contains an account of how the frustrated author, unable to carry out his craft adequately because his master had died before teaching him the necessary techniques, tried to contact the deceased. The attempt was only half successful. The master's shade spoke only to say that he was not allowed to relay information freely across the gulf that now divided him from the living, and that "the books are in the temple." A little later, a pillar in the temple suddenly opened up to reveal a hidden niche containing a terse expression of the master's secret knowledge: "Nature delights in nature, nature triumphs over nature,

nature masters nature.”⁸ (This is not the only tale of alchemical secrets suddenly revealed in a place of worship.) This repetitive and rather obscure phrase is used like a refrain throughout the recipes of the *Physika kai mystika*. Whatever meaning we attach to this tale of discovery, the recipes themselves remain straightforward and practical, with no trace of the mystical (in a modern sense) or the supernatural.

The Birth of Alchemy

The recipe literature such as the Papyri and the *Physika kai mystika* aims to imitate or extend precious materials. But probably during the third century AD, a crucial juncture in the emergence of alchemy was reached. At some point—no texts survive to inform us of exactly how or when this first happened—the idea of actually making *real* gold and silver emerged. This development would have seemed reasonable enough from the point of view of a worker at that time. If the water of sulfur can tinge the surface of silver to look like gold, why shouldn't there be some way to tinge it through and through—even more than that, to give silver not only the color of gold but *all* the properties of gold? The process for making gold is called *chrysopoeia*, from the Greek words *chryson poiein* (to make gold), and it is accompanied by the less common (and less lucrative) *argyropoeia*, the making of silver. The general process of transforming one metal into another is called *transmutation*.

From this point onward, alchemists had a coherent goal toward which to strive with both head and hand. They would pursue a great many things besides chrysopoeia, but the making of gold and silver remained one of the central goals of what would come to be called the Noble Art. The authors of the earliest alchemical treatises borrowed techniques, processes, and tools from a wide variety of contemporaneous artisans, yet they saw themselves as a group distinct from those artisans.⁹ Thus, both alchemy and alchemists acquired an independent identity in the third century.

The birth of alchemy required the union of two traditions: the practical artisanal knowledge exemplified in the recipe literature, and theoretical speculations about the nature of matter and change present in Greek natural philosophy: What is matter? How does one thing change into another? A Greek speculative tradition centering on these questions

stretched back for some seven hundred years before the emergence of alchemy. Such questions preoccupied the earliest Greek philosophers, known collectively as the pre-Socratics. The first thinker generally cited in this tradition is Thales of Miletus (sixth century BC), who claimed that all the different substances around us are really modifications of a single primordial substance that he identified as water. Many other thinkers followed Thales with their own ideas. Democritus and Leucippus (fifth century BC) proposed the concept of invisibly small *atomoi* (atoms), from which everything is composed. Empedocles (circa 495–435 BC) attributed the origin of natural substances and their transformations to four “roots” of things he called fire, air, earth, and water. These four combine in various ways and separate under the influence of forces he called love and strife. Perhaps most prominently of all, Aristotle (384–322 BC) devoted substantial attention to the nature of matter and change, devising theories and ways of thinking that would prove highly influential and fertile for further investigations.

All these Greek philosophers endeavored to explain matter’s hidden nature and to account for its unending transformations into new forms. Most of them embraced the idea that beneath the constantly changing appearances of things, there existed some sort of a stable, unchanging substrate. The notion that a single ultimate substance lies beneath all material things is known as *monism*. For Thales, this ultimate substance was water; for Democritus, imperishable atoms; for Aristotle, what he called “first matter” or “prime matter” (*prōton bylē*). Empedocles’ four elements, strictly speaking, represent a position of *pluralism*, since he implied that more than one kind of ultimate matter exists, but he nevertheless maintained the idea of a constancy beneath change. So far as we know, however, these natural philosophers had only a secondhand acquaintance with the practical knowledge of the crafts.

In the cosmopolitan crossroads of Greco-Roman Egypt, the two streams of craft traditions and philosophical traditions coexisted. Their merger—probably in the third century AD—gave rise to the independent discipline of alchemy. The intimate mingling of the two traditions is evident in the earliest substantial texts we have about chrysopoeia. These writings come from a Greco-Egyptian alchemist who would be revered as an authority for the rest of alchemy’s history, and the first about whom we have any reasonably substantial or reliable historical details: Zosimos of Panopolis.

Zosimos of Panopolis

Zosimos was active around 300 AD.¹⁰ He was born in the Upper Egyptian city of Panopolis, now called Akhmim. We know that he was not the first chrysopoeian, because his writings refer to earlier authorities, and even to rival “schools” of alchemical thought that had already developed by his time. (Of these other schools we know absolutely nothing save what he writes in criticism of them.) Zosimos is thought to have written twenty-eight books about alchemy; alas, most of what he wrote is now lost. We have only scraps: the prologue to a book titled *On Apparatus and Furnaces* (sometimes called the *Letter Omega*, under which letter it was once classified),¹¹ several chapters from other works, and scattered excerpts. Some of Zosimos’s writings are addressed to Theosebeia, a woman who seems to have been his pupil in alchemical matters, although whether she was a real person or a literary device we will never know for sure. Despite the fragmentary nature of what survives and the difficulty in interpreting it, these writings provide the best window we have onto Greek alchemy. Surprisingly, these early texts establish many concepts and styles that would remain fundamental for much of later alchemy.

Zosimos’s orientation toward a central goal (metallic transmutation), his insightful engagement with the practical problems in reaching it, his search for the means of surmounting these problems, and his formulation and application of theoretical principles clearly underscore his writings as something new and significant. While earlier texts are recipe miscellanies, Zosimos’s texts witness a coherent program of research that draws on both material and intellectual resources. He describes a wide array of useful apparatus—for distillation, sublimation, filtration, fixation, and so forth—in great detail.¹² Many of these instruments are adapted from cooking utensils or items used in perfumery or other crafts. Zosimos did not devise all these instruments himself, indicating how developed practical chrysopoeia must already have become by the start of the fourth century AD. The writings of his predecessors form a key resource for him, and he cites them frequently. One of the most prominent authorities is named Maria—sometimes called Maria Judaea or Mary the Jew—and Zosimos credits her with the development of a broad range of apparatus and techniques. Maria’s techniques include a method of gentle, even heating using a bath of hot water rather than an open flame. This simple but useful invention preserved the legacy of Maria the ancient alchemist,

not only for the rest of alchemy's history, but even down to the present day. It is her name that remains attached to the *bain-marie* or *bagno maria* of French and Italian cookery.

Several of the pieces of apparatus Zosimos describes—for example, one called the *kerotakis*—are designed to expose one material to the vapors of another. Indeed, he seems particularly interested in the action of vapors on solids. This interest is partly grounded on practical observations. Ancient craftsmen knew that the vapors released by heated *cadmia* (or calamine, a zinc-containing earth) could turn copper golden by transforming it into brass (an alloy of zinc and copper). The vapors of mercury and arsenic whiten copper to a silvery color. Perhaps knowledge of these color changes induced Zosimos to seek analogous processes that would bring about true transmutations. Guiding theories are certainly discernible in his writings. This is a crucial point to stress. Today there is a common misconception that alchemists worked more or less blindly—stumbling about mixing a little of this and a little of that in a random search for gold. This notion is far from the truth; already with Zosimos we can identify *theoretical principles* that guided his practical work, as well as *practical observations* that supported or modified his theories. Many theoretical frameworks for alchemy would develop in various times and places, and these frameworks both supported the possibility of transmutation and suggested avenues for pursuing it practically.

In the case of Zosimos, not enough of his work survives to map out his thinking fully. Yet it is clear that he viewed the metals as composed of two parts: a nonvolatile part that he calls the “body” (*sōma*) and a volatile part that he calls the “spirit” (*pneuma*). The spirit seems to carry the color and the other particular properties of the metal. The body seems to be the same substance in all metals; in one fragment Zosimos appears to equate it with the liquid metal mercury. Thus, the identity of the metal is dependent on its spirit, not its body. Accordingly, Zosimos uses fire—in distillation, sublimation, volatilization, and so on—to separate the spirits from the bodies. Joining separated spirits to other bodies would then bring about transmutation into a new metal.

Across the gulf of ages, Zosimos's observant, active, questioning mind makes itself apparent. In one passage, he notices the disparate effects of sulfur vapor on different substances, and expresses his astonishment that while the vapor is white and whitens most substances, when it is absorbed by mercury, which is itself white, the resulting composition

is yellow. Always ready to criticize his contemporaries, Zosimos chides them by saying that “they should inquire into this mystery first of all.”¹³ He likewise expresses his surprise that when the vapor of sulfur turns mercury into a solid, not only does the mercury lose its volatility and become fixed (that is, nonvolatile), but the sulfur also becomes fixed and remains combined with the mercury.¹⁴ Zosimos’s observation is now recognized as a basic principle of chemistry: when substances react with one another, their properties are not “averaged,” as they would be in a mere mixture, but instead completely changed. Clearly, Zosimos was a careful observer who thought deeply about what he witnessed experimentally.

Zosimos calls transmutation the “tingeing” of metals, and uses the word *bapbē*, from the verb *baphein*, which means “to dip” or “to dye”; he likewise calls a transmuting agent a “tincture,” that is, something able to tint or color. These word choices signal the connection of his ideas to the recipe literature, which was primarily concerned with coloring metals, stones, and cloth to produce precious (or apparently precious) objects. Accordingly, the “water of sulfur” reappears prominently in Zosimos, but now with strikingly new meanings. It is no longer a simple composition for bringing about superficial changes but rather some putative substance able to bring about real transmutation—and consequently something eagerly sought and eagerly hidden.

Here an almost ubiquitous feature of alchemy appears: *secrecy and the hiding of names*. Zosimos delights in playing with the name of this substance. Thanks to an ambiguity in the Greek language, in some contexts the name can mean either “water of sulfur” or “divine water.” In some places he intends the name to mean a transmuting agent, while in others he is clearly talking about the simple lime-sulfur composition of the recipe literature.¹⁵ In yet another place he describes it as “the silvery water, the hermaphrodite, that which flees without ceasing . . . it is neither a metal, nor a water always in movement, nor a solid body, for one cannot grasp it.”¹⁶ In this case his riddle for “divine water” seems to describe mercury, presented as the basic substrate for all metals. Elsewhere, the same term seems to have yet other meanings. In point of fact, in a Zosimos text just recently identified, the Egyptian admits freely that alchemical writers “call a single thing by many names while they call many things by a single name.”¹⁷ He notes that the production of transmuting “waters” is “the manifest secret, that which is studiously hidden.”¹⁸ The moderate level of secrecy encountered in the earlier recipe literature thus becomes

more intense and more self-conscious with Zosimos. Such secrecy would wax and wane in intensity but never disappear for the rest of alchemy's history.

To promote such secrecy, Zosimos employs a technique that would become typical for alchemical authors: the use of *Decknamen*, a German term meaning "cover names." These *Decknamen* function as a kind of code. Instead of using the common name for a substance, the alchemical writer substitutes another word—usually one that has some link, literal or metaphorical, with the substance intended. There is already some hint of this technique in pseudo-Democritus, where he uses the adjective *our* to specify a substance other than that usually meant by a common term; for example, he uses "our lead" to mean the mineral antimony (stibnite), a substance that shares some properties with lead. *Decknamen* serve a dual purpose: they maintain secrecy, but they also allow for discreet communication among those having the knowledge or intelligence to decipher the system. They simultaneously conceal *and* reveal. Consequently, *Decknamen* have to be *logical*, not arbitrary, so that they can be deciphered. If *Decknamen* could not be deciphered by readers, then total secrecy would be the result; and if the intent were to conceal information entirely, it would be far simpler for alchemists to have written nothing at all.

The encoding of information does not stop with simple replacements of the names of substances, not even in Zosimos. Perhaps the most famous fragments of the Panopolite are sometimes (and misleadingly) called his "Visions." Three fragments describe a series of five "dreams" separated by periods of waking. These dreams involve an altar shaped like a chemical vessel, various men of copper, of silver, and of lead, their violent dismemberment and death, and Zosimos's conversations with them. Much ink has been spilled trying to explain what these texts really mean. Regardless of the varied answers that have been offered over the past century or so, Zosimos himself tells us that they are allegorical descriptions of practical transmutational processes. In other words, the actors, places, and actions described are personified *Decknamen* woven into a coherent and extended narrative. Such allegorical language would remain a common feature of alchemical writing, and become especially prominent in works by European practitioners starting in the fourteenth century.

Zosimos calls his dream sequence a “prologue” intended to help the reader unveil the “flowers of speech” (*anthē logōn*) that follow. In the text as we have it today, only one practical process follows, but it appears that originally there were many more, now lost.¹⁹ In another place, Zosimos writes clearly that after “awaking” from a dream, he “understood very well; those who busy themselves with these things [the events in the dreams] are the liquids of the metallic art.”²⁰ In the book *On Sulphurs*, Zosimos uses a simile that compares the transmutation of lead into silver to a tormented man who becomes king; this image, which the text clearly links to a practical process, is very similar to those expressed in Zosimos’s second “dream.”²¹

Some modern writers have read various mystical or psychological meanings into Zosimos’s allegorical accounts, but in so doing they have largely ignored their context—both within the corpus of his writings and within his cultural milieu. Zosimos clearly states that his “dreams” have a technical meaning in the context of the transmutation of metals—the primary topic of his texts. Some scholars have even proposed plausible interpretations of the “dreams” in terms of the Panopolite’s alchemical theories and laboratory practices.²² It is certainly possible that Zosimos did in fact dream (or daydream) about the work in which he was so deeply engaged; many readers have probably had similar experiences of work-related matters reexpressing themselves in strange dreams. But it is more probable that Zosimos composed these “dreams” explicitly, much like a fiction writer works, thus creating a self-consciously allegorical “prologue” for one of his practical treatises. This practice harmonizes well with his routine use of secrecy, and in fact, immediately after reciting one of these “dreams,” he declares axiomatically that “silence teaches excellence,” as if to explain his own relative silence and to advise an analogous silence for his readers.²³ The use of dreams as a literary device was an established and popular practice in Zosimos’s day, and placing information into the form of a dream gives it a certain cachet—an air of authority and a tone of revelation.

Yet showing that the core meaning of Zosimos’s “dreams” lies in practical alchemical operations does not mean we can ignore their broader cultural context. Zosimos surely drew upon his own experience and knowledge of contemporaneous religious rites for imagery to use in this allegorical sequence. His language of altars, dismemberment, and sacrifice surely reflects something of late Greco-Egyptian temple practices.

This recognition brings up a huge point for the entire history of science: how do practitioners' philosophical, theological, religious, and other commitments manifest themselves in the study of the natural world, whether in alchemy or elsewhere? Such studies—be they alchemical or modern scientific—do not occur in a cultural vacuum, nor are practitioners somehow insulated from the conceptions, interests, and ways of thinking of their particular time and place. Chapter 7 deals with the inseparability of such matters from alchemy and indeed from all scientific pursuits more generally. For now, it suffices to take one last illustrative look at Zosimos.

There is undoubtedly a link between Zosimos and Gnosticism. Gnosticism was a diverse grouping of religious movements of the second and third centuries AD that stressed the need for revealed knowledge (*gnōsis*) to achieve salvation.²⁴ This salvific knowledge included the realization that man's inner being was of divine origin but had become imprisoned in a material body. Knowledge was necessary to overcome man's ignorance (or forgetfulness) of his origins, enabling him to begin liberating himself (that is, his soul) from subjection to the body and its passions, and to the material world and the evil forces that govern it. The Gnosticism widespread in Zosimos's Greco-Egyptian milieu surfaces clearly in two places in his writings. One is the prologue to his *On Apparatus and Furnaces*, and the other is the fragment called the "Final Account."²⁵ The question is how and to what extent Gnostic ideas play a role in Zosimos's alchemical ideas.

In the first text, Zosimos rails against a group of rival alchemists who criticize *On Apparatus and Furnaces* as unnecessary. He counters that they think this way only because they are using phony tinctures (transmuting agents) whose apparent success is actually the result of spiritual beings called daimons.²⁶ The daimons trick these errant alchemists into believing that their preparations work, and as a result they claim that the specific equipment, materials, and procedures stipulated by Zosimos are not needed for success. The daimons thus use these false tinctures to manipulate their ignorant possessors, thereby keeping them under daimonic sway and subjected to Fate (an evil force to be rejected). What true alchemists seek, Zosimos declares, are tinctures that are purely "natural and self-acting," bringing about transmutation by the operation of their natural properties alone.²⁷ To prepare these true, natural tinc-

tures, the right apparatus and the right ingredients and processes are absolutely necessary.

To drive home his point about the baleful results of allowing oneself to fall under the sway of daimons, Zosimos then gives a Gnostic account of the Fall of Man—how the original human being was deceived by maleficent spirits into being embodied as Adam. Zosimos reveals a Christian form of Gnosticism by recounting how Jesus Christ provided human beings with the knowledge needed for salvation, namely, the need to reject their “Adam” (the material body) in order to ascend again to their proper divine realm. Human imprisonment and its attendant evils thus arose in the first place from daimonic deception, just like that which now causes the errant alchemists to reject Zosimos’s book. Surely, these bad alchemists are making their own circumstances worse by blindly continuing to be duped rather than liberating themselves from daimonic control. Zosimos’s critical prologue must have originally provided an appropriate introduction to his (now lost) text about the furnaces and apparatus necessary for preparing a true transmuting tincture.

Does Gnosticism express itself visibly in Zosimos’s alchemical theories or practices? Possibly. Given the Gnostics’ fondness for casting their tenets into myth format, we could wonder if Zosimos’s choosing to put alchemical processes into an allegorical dream sequence arises from the same tendency to mythologize doctrines—Gnostic or alchemical. Additionally, Zosimos’s guiding theory of the twofold nature of metals (body and spirit) and the practical need to free the active, volatile soul from the heavy, inert body in order to achieve transmutations seems to parallel Gnostic views—and some other contemporaneous theological views—of man’s divine soul as being trapped in a material body, and the consequent need to free it. For a Gnostic (or a Platonist, for that matter, and Zosimos wrote about Plato as well), human individuality and personality are found in the soul, not the body. In the same way, the metals draw their particular nature and identity from their *pneuma*, not their *sōma*.

We completely miss the fullness and multivalent complexity of pre-modern thought if we dissect it into modern categories. Zosimos had no reason to isolate his philosophical or theological commitments into special categories separated from the balance of his thought. Today there is a tendency to imagine that such “mixing” (it is mixing only from our perspective) somehow impedes rational and clearheaded work on practical

matters, yet this is not only a modern prejudice but also far from true. Zosimos's methods—like anyone else's—of thinking about, conceiving, and interpreting his work could not help but be influenced by, and draw on, the totality of the way in which he conceived of the world as a whole. Thus, it is incorrect to say that alchemy for Zosimos was itself a religion, and an exaggeration to say that his alchemy was Gnostic. Yet it is equally wrong to imagine that Zosimos could (or should) “turn off” his ways of thinking, his mental landscape built upon contemporaneous Gnostic, Platonic, and other commitments, when at work on practical alchemical processes. Even modern scientists cannot do that, although some of them convince themselves that they can (perhaps under the trickery of a daimon named Pure Objectivity).

Before we leave Zosimos's time and place, there is one more piece of context to add. If scholars are correct to date Zosimos's activity to around 300 AD, then he witnessed not only Emperor Diocletian's violent suppression of a rebellion in Egypt in 297–98 but also the attempted destruction of alchemy's literary heritage by the same emperor. It is reported that Diocletian ordered all “books written by the Egyptians on the *cheimeia* of silver and gold” to be burned. The source, an account of the martyrdom of Christians during Diocletian's persecutions, claims that this measure was taken to prevent the Egyptians from amassing enough wealth to rebel again.²⁸ However, if indeed this book burning took place as reported, it may have been related to Diocletian's empire-wide monetary reforms, which included the replacement in 295–96 of Egyptian provincial coins (minted at Alexandria) with standard Roman currency.

The third century AD witnessed a steady monetary collapse for the Roman Empire. Mints increasingly debased the currency by striking coins containing less and less precious metal, thus widening the gap between the coins' face value and their intrinsic worth. The amount of silver in the coin called the *antoninianus*, for example, dropped from 52 percent to less than 5 percent. Many issues of bronze coins were given a superficial silver (or merely silvery) coating to make them appear to be worth more than they really were. Diocletian's solution (which ultimately proved unsuccessful) was to issue new coinage.²⁹ Since the Egyptian books often described means of mimicking precious metals, hiding the debasement of alloys, or—in the ideal case—producing new gold and silver, it seems that these sorts of processes would be the last thing a ruler intent

on monetary stabilization would want to have around, especially in the hands of a rebellious province of the empire. Significantly, a substantial number of late antique coins made of imitation precious metal have recently been identified, and the composition of some of them is strikingly similar to what would be produced following the recipes in the Papyri and pseudo-Democritus.³⁰ If the fear of counterfeiting and currency debasement lay behind Diocletian's decree, it would be the first in a long line of concerns over the value of currency that resulted in proscriptions against alchemy. The imperial edict banning books about *cheimeia* might also provide some of the background for the enhanced level of secrecy apparent in Zosimos's writings.

Whether or not this last suggestion is correct, one feature of this account remains: it is one of the earliest usages we have of a term—*cheimeia*—from which the words *alcbemy* and *chemistry* derive. It is now time to say something about these two words. As with so much of alchemy, many unreliable claims have been made about their origin. This situation dates to the alchemists themselves, who loved to indulge in drawing fanciful etymologies in order to make various claims about their discipline. A common practice in antiquity was to trace the name of a thing to that of a mythical founder—hence Rome draws its name from the mythical Romulus, for example. Zosimos refers to an early alchemist named Chēmēs or Chymēs, and in another passage claims that the art was initially revealed by an angel in a book titled *Chēmeu*.³¹ Zosimos undoubtedly drew the germ of this notion from the apocryphal Hebrew *Book of Enoch* (or 1 Enoch), wherein fallen angels teach the productive arts to mankind. But even modern texts about the history of alchemy or chemistry often present unlikely origins. One popular notion is that *chemistry* derives from the Coptic word *kbeme*, meaning “black,” alluding to the “black land,” Egypt, in reference to the color of Nile silt. There is some support for this notion, since the first-century-AD writer Plutarch notes that *chēmia* was an old name for “Egypt.”³² Hence, according to this theory, *chemistry* would literally mean “the Egyptian art.” Less plausibly, others have linked this derivation to the “black stage,” a crucial step toward effecting transmutation, or to the imagined nature of alchemy as a “black art.”

But the word more likely has a Greek origin, given that Greek was the language both of the earliest alchemical texts and of literate Greco-Roman Egypt. The “chem” of *alcbemy* and *chemistry* very probably

derives from the Greek *cheō*, which means “to melt or fuse.” *Cheō* also gives rise to the Greek word *chuma*, which signifies an ingot of metal. Since most of the early chemical practices involved the melting or fusing of metals, this etymology certainly seems the most plausible and reasonable. The Greek word for the subject is then *chemeia* or *chumeia*, literally an “art of melting [metals].” (A predominantly Greek etymology does not, however, rule out a double meaning that draws also on the Coptic root.) By the way, the use of the word *alchemy* in referring to the Greco-Egyptian period could be seen as an anachronism, since that word is an Arabized form of the older Greek term—the “al” of *alchemy* is simply the Arabic definite article. (So what Zosimos and his contemporaries practiced should perhaps be called “chemy” . . .) But more on terminology later.³³

Later Alexandrian and Byzantine Authors

Several Greek texts about *chemeia* dating from after the time of Zosimos down to the eighth century survive.³⁴ Most are commentaries on earlier material, and as is the case with so much of early alchemy, several of their authors await further and more careful study. One important development within this material is a greater melding of the practical with the theoretical and philosophical. From Olympiodoros, a writer of the sixth century AD, we have a fragmentary commentary on a now-lost work of Zosimos. This Olympiodoros may very well be the philosopher of the same name who wrote commentaries on Aristotle. He followed the lead of earlier Greek thinkers—such as Thales—who sought to identify a universal material from which everything is made. Olympiodoros reorients this idea of a common material substrate to speak of a common “matter of metals,” which, by being receptive to a variety of different qualities, gives rise to the various metals. Thus, transmutation would be accomplished by reducing a metal to its “common metallic matter” and then introducing the qualities of the desired metal. This idea of a common metallic matter subject to interchangeable sets of qualities seems a continuation of Zosimos’s division of metals into “body” and “spirit.” Interestingly, Olympiodoros also justifies the use of allegory in place of plain language in alchemy by noting how Plato himself used the same literary device when teaching his most important points.³⁵

Stephanos of Alexandria, a Neoplatonic philosopher, commentator,

astronomer, and scholar, wrote an alchemical work titled *On the Great and Sacred Art of Making Gold*, which has recently been dated to 617. In this book he explicitly applies ideas from Plato, Aristotle, and other notable Greek philosophers to alchemy.³⁶ Unlike Zosimos, however, neither Olympiodoros nor Stephanos seems to have been interested in practical work. Alchemy did not constitute their main interest; they were philosophical thinkers first. Accordingly, chrysopoeia was for them a philosophical issue, and perhaps we might think of them—at least from what we know presently—as armchair alchemists. Nevertheless, their application of Greek philosophical thought, especially regarding matter, to alchemy continued the construction of an increasingly sophisticated theoretical framework for chrysopoeia. Such developments were significant not just in themselves, but also because these later versions of alchemy would be inherited by the Arabic world.

An often-reproduced image that comes from Marcellinus graecus 299 is probably an emblematic expression of the philosophical principle upon which so much Greek alchemical theory and practice is based. This figure is known as the *ouroboros*, a serpent swallowing its tail (fig. 1.1). Interpretations of this simple but arresting image vary widely. But the

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Figure 1.1. The *ouroboros* from Marcellinus graecus 299, fol. 188v. Reproduced in Marcellin Berthelot, *Collection des alchimistes grecs* (Paris, 1888), 1:132.

inscription within it—ONE THE ALL (*ben to pan*)—directs us again toward ancient Greek philosophical notions about a single material that serves as the underlying substrate for all substances. Clearly, this principle undergirds the idea of alchemical transmutation: one thing can be turned into another because at the deepest level they are really the same thing. Thus, as things appear to pass away and new things come to be, there is a sense in which they remain always the same: one thing is all things, all things are one thing. Thus, the serpent *ouroboros*, like the sum total of material substances, continuously consumes itself and produces itself from itself, remaining constant even while perpetually destroying and regenerating itself.

One other development is worth mentioning before departing the Greek-speaking world for the Arabic: new names for a specific substance that would bring about transmutation. In Zosimos, this substance is one of several things he meant by the phrase “water of sulfur.” Another term he uses is *xērion*, which originally meant a medicine in the form of a powder to be sprinkled on wounds. This term may have been chosen for its relation to the word *pharmakon* (drug, salve, poison), occasionally used by pseudo-Democritus for various substances able to color metals. But the term *xērion* suggests another parallel, namely, that just as medicine heals and improves sick human beings, *chemeia* heals and improves base metals by the use of its own “medicine,” the *xērion* or transmuting agent. This powerful agent of transmutation would acquire a new and more enduring name that appeared no earlier than the seventh century: *bō litbos tōn philosophōn*, the Philosophers’ Stone. Discovering how to prepare that “stone which is no stone” would become the alchemists’ paramount goal.³⁷

DEVELOPMENT

Arabic *al-Kīmīyā'*

Alchemy developed extensively during its Arabic period, roughly 750 to 1400, augmented in every respect by new theories, concepts, practical techniques, and substances. Centuries of cultivation in the Islamic world produced a massive body of knowledge across the sciences, medicine, and mathematics that would earn the awe and admiration of medieval Europeans when they first encountered it in the twelfth century. Yet although medievals recognized the wealth and importance of Arabic scholarship, that esteem gradually eroded in later generations, until the contributions and even the names of influential Arabic authors became confused, forgotten, or even suppressed. Thus, despite the importance of this period for alchemy—and for the entire history of science—our knowledge of it remains very incomplete. Historians have had to rediscover the primary sources of Arabic alchemy. Only at the end of the nineteenth century did scholars begin to study Arabic alchemical texts again. Strikingly enough, we owe part of this renewal of interest to the chemist Marcellin Berthelot (1827–1907), the same person responsible for the publication of the Greek *Corpus alchemicum*.¹

Since that time, many questions have been addressed, many gaps in our understanding filled, and many mysteries solved, but much more still awaits attention. Even for the most important Arabic authors, only a few texts have been edited, and fewer translated. Much-needed new scholarship has been stymied by the inherent complexity of the manuscripts and their loss through war and carelessness, as well as by regional political and economic situations that prevent free access to archives. Perhaps the most challenging problem, however, is the very small number of historians of science with linguistic skills in Arabic, and the yet smaller subset of these with an interest in alchemy.

The Transmission of Knowledge from Greeks to Arabs

In the mid-seventh century, shortly after the beginnings of Islam, Arab armies surged out of the Arabian Peninsula in all directions—north into Palestine and Syria, east into Persia, west across North Africa, and finally into Spain and even France. Most important for the story of alchemy is the Arab conquest of the Byzantine lands in the Eastern Mediterranean. In 640, the city of Alexandria was conquered and Egypt annexed to the Islamic Empire. There and in other formerly Byzantine holdings in the Middle East, the nascent Muslim world came into close contact with Greek ideas and culture. This intercultural contact strengthened in 661, when Mu'āwiyah, the second caliph (successors of the prophet Muhammad acting as leaders of Islam) of the Umayyad dynasty, established his capital at Damascus, in the heart of what just thirty years earlier had been Byzantine land. Thus, although the Umayyad caliphs were Muslim Arabs, their subjects were largely Byzantine Christians. The new Muslim rulers were skilled in warfare but not in running an empire, so they needed to employ experienced Byzantines as administrators, architects, and planners. This sociopolitical situation offered ample opportunity for the newly arrived Arabs to learn Greek ideas. Thus, a “translation movement” began, slowly and haltingly under the Umayyads, but greatly accelerated under their successors, the 'Abbasids, who moved the Islamic capital east from Damascus to the new city of Baghdad, which they founded in 762. There a host of translators labored to render hundreds of Greek books into Arabic: the writings of Aristotle and Plato, the mathematics of Euclid, and the medicine of Galen and

Hippocrates, as well as practical treatises dealing with technology, mechanics, and, of course, *chemeia*.²

We used to think we knew exactly how Greek *chemeia* first established itself in Arabic culture as *al-kīmiyā*. The story begins engagingly enough with intrigue and murder at the Umayyad court in Damascus. Khālid ibn-Yazīd (died 704) was a young Umayyad prince, grandson of the caliph Mu'āwiyah. When Khālid's father died in 683 while besieging Mecca during a civil war, Khālid's elder brother succeeded to the caliphate, but died the next year at the age of twenty-two—and possibly not of natural causes. Because of Khālid's youth, the caliphate was then given to a relative by the name of Marwan, with the condition that Khālid would succeed him. But Marwan then married Khālid's widowed mother, promised the line of succession to his own sons, and declared Khālid a bastard. Khālid's mother's response was to smother her new husband with a pillow while he slept (some sources say she poisoned him). Given such a loving family, Khālid fled to Egypt. There, to put his lost caliphate behind him, the young prince began to study Greek learning, and found alchemy most to his liking. In some versions of the story, he encountered "Stephanos the elder," presumably the author Stephanos of Alexandria mentioned in chapter 1. Stephanos taught Khālid and translated alchemical books into Arabic for him. In other versions of the story, Khālid's instruction came instead from a Christian monk named Marianos. Accounts disagree on whether this monk was Greek or Roman, and whether or not he lived as a hermit in Jerusalem. In any event, Marianos had studied alchemy in Alexandria, supposedly under the tutelage of Stephanos, and shared that knowledge—including how to prepare the Philosophers' Stone—with Khālid. The prince himself then wrote several alchemical works to preserve the instructions he had received.

Khālid's books, and his status as "the first [Muslim] for whom medical, astronomical, and chemical writings were translated," are already recorded in a tenth-century Arabic source, as is the Christian monk Marianos.³ Marianos's books are known today both in Latin translation and in Arabic.⁴ Unfortunately, this tidy and engaging tale is pure fiction.⁵ The books bearing the names of Marianos and Khālid ibn-Yazīd are actually compositions dating a century or more after the lifetimes of their reputed authors.