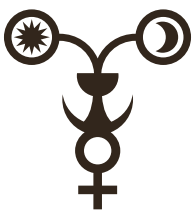
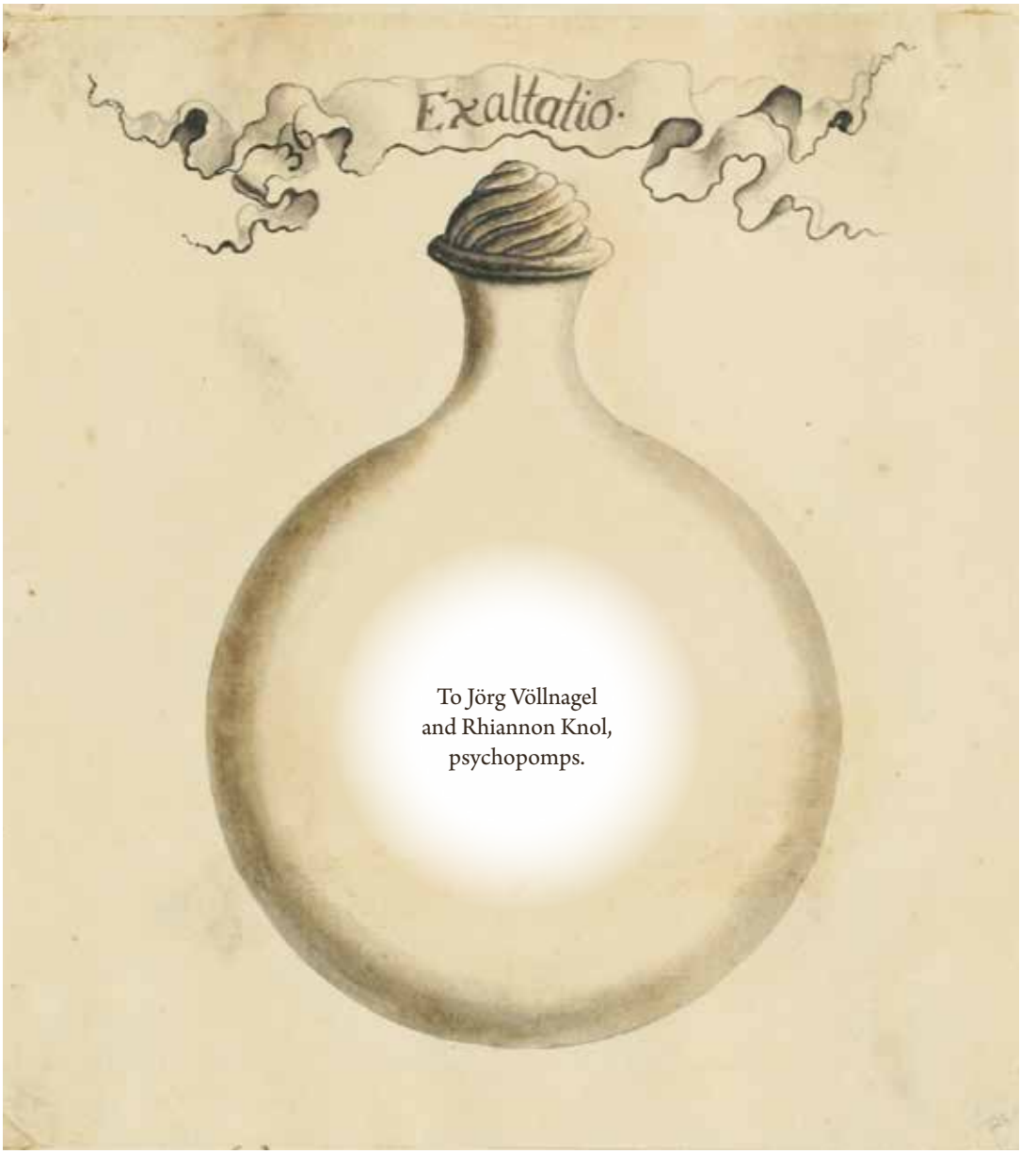
DAVID BRAFMAN



ART *of* ALCHEMY

Lannoo



To Jörg Völlnagel
and Rhiannon Knol,
psychopomps.

Exhaltatio
Anonymous, *Book of the Seven Seals* (Germany, ca. 1700)

CONTENTS

ALCHEMY

THE GREAT ART

What is alchemy? Anyone who asks this question should expect hesitation before an answer. The simplest reply would be that alchemy is the ancestor of chemistry. Certainly, a study of its history can be (and has been) approached simply by placing it on a timeline of scientific development. But, to quote Victor Frankenstein, "A man would make but a very sorry chemist if he attended to that department of human knowledge alone."

There's another reason to hesitate: When researching a subject, it is not unusual to see it everywhere and see everything as relevant to it. The problem is, in the case of alchemy, it *is* everywhere. Alchemy, like one of its principal laboratory ingredients, is mercurial, and a focused study of the subject can be maddening to the researcher. For its pursuits span the history of humanity as it puzzled over how the world—and everything in it—was created. In alchemy, solving the puzzle meant painstakingly testing how the world's pieces fit together, and the proof of the solution was synthetically replicating the process of their tailored fit.

Alchemy was the art of transforming natural matter into "man"-made creations. The ancient technology that spawned alchemy was endowed with miraculous power. Fire could transform sand into glass, and copper be extracted from rocks like malachite and azurite by subjecting them to flame. In both cases, natural matter is "transmuted" into malleable materials that can be molded into artistic form (or wielded as weapons of war). Furthermore, processes that require millennia in nature can be vastly accelerated in a laboratory context. Alchemy could not only imitate the action of natural creation—it could hasten, perfect, and even surpass it.

In the academic past, when physics and chemistry were unified under the heading "natural philosophy" with the intellectual aim of grasping nature, the techniques of alchemy were the tools that philosophers, scientists, and artists alike reached for to emulate the elements of nature. Perhaps it was also the elusive nature of alchemy that made its study so seductive. The promise that its secrets could tease out pure gold or manufacture immortality from the matter mined from nature captivated centuries of thinkers and experimenters.

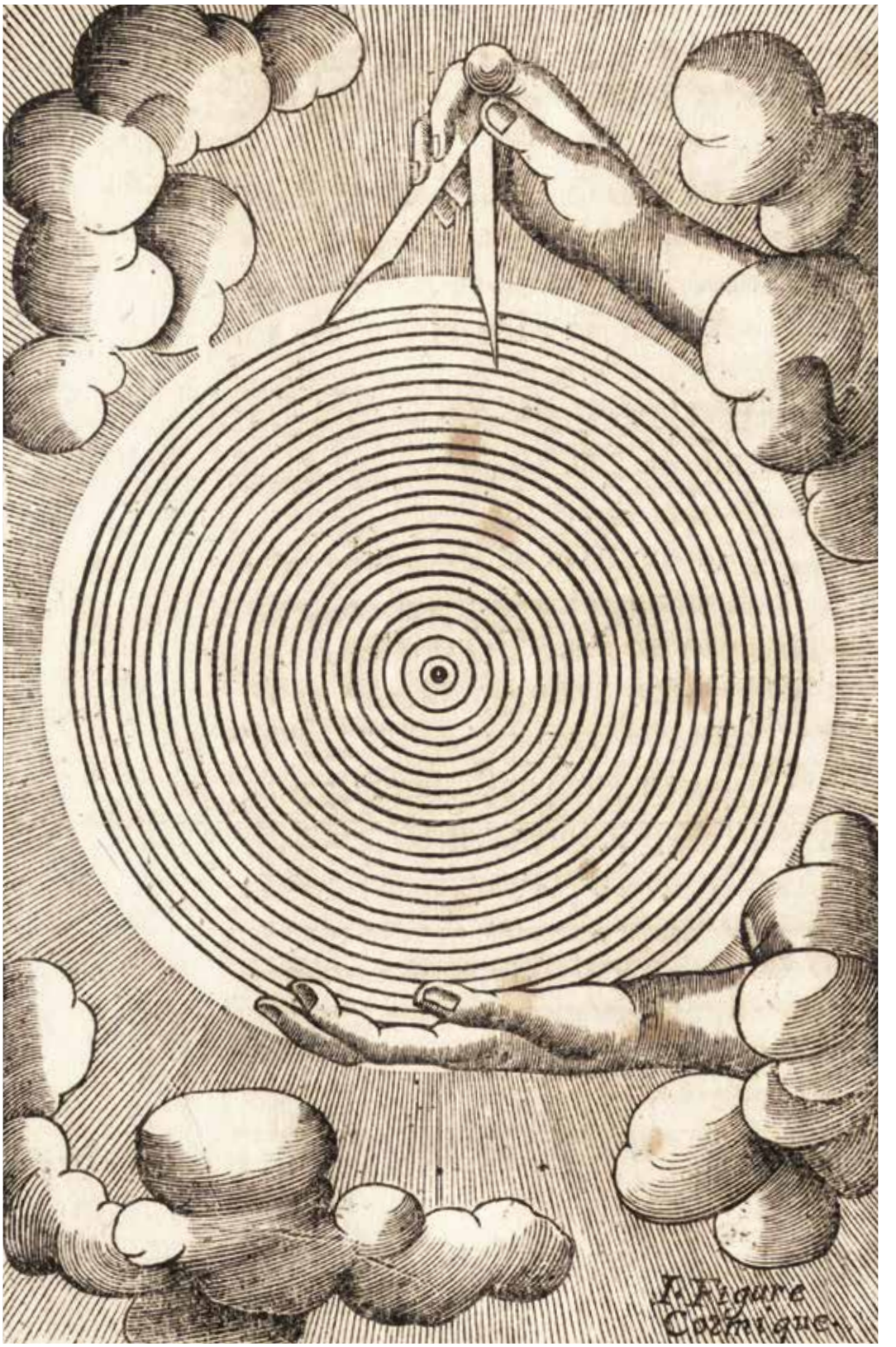
Alchemy seemed to hold the key to unlocking the mysteries of creation itself, and that scientific fascination with grasping and wielding the powers of nature often found expression through artistic imagination and imagery. In fact, alchemy was called *ars magna*—the "Great Art"—in medieval Europe. In Islam, it was simply *al-ṣanʿat*—"The Art." The twelfth-century theologian Albertus Magnus wrote that "alchemy is the art that best imitates nature." While other art forms sought to imitate nature by "capturing" it—for example rendering a pictorial or sculptural reproduction of it—alchemy chemically replicated nature. For alchemists, grasping the scientific secrets that created natural phenomena was synonymous with directing and manipulating the forces that drove them, perfecting techniques to create synthetic replicas of the physical stuff of nature. The goal of alchemy was to truly recreate, not merely illustrate, the world around us.

By the thirteenth century, a new generation of faculty at the universities of Paris and Oxford—among them such luminaries as St. Thomas Aquinas and Roger Bacon—continued to grapple with the theological controversy that swirled around the possibility that alchemy possessed sufficient scientific and creative power to be considered a serious contender, poised to challenge the primacy of divine natural creation. The assertion was considered radical, and a *cause célèbre* in the medieval European academy. The idea, however, was not a new one at all. It was simply an inheritance of millennia of thinkers questioning the nature of Nature, and the innovative work of human hands that fashioned artistry from the stuff of the material world.

Alchemy may well be the most important human invention after that of the wheel and the mastery of fire. For the history of art alone, chemical experimentation yielded oil paints, writing inks, color pigments, and dyes; cements and metal alloys for sculpture, engineering, and architectural ornament; transparency in glass and the opacity of reflective mirrors; acidic washes essential to etching and lithography; and the media that now claim artistic boasting rights as the ultimate chemical mirrors of nature—photography and the liquid crystal displays of the digital world.

In a larger cultural sphere, history credits alchemists with the invention and advancement of pharmaceutical medicine—a particularly fortunate happenstance, as it was also alchemists who invented gunpowder and pushed the limits of its pyrotechnic force from dazzling fireworks to deadly bombs. The theoretical framework within which alchemy operated—the scientific urge to understand and harness the elemental properties forming the basis of all physical matter—also informed the core of modern nuclear physics. Alchemy in its many transmutations has manifested itself throughout the history of world civilizations, and its spirit—the urge to transform nature and bend it to the will of an industrious human imagination—still permeates the world we make today.

So, what was alchemy? A science, for sure—yet one tinged with spirituality and infused with a spritz of artistic spirit.



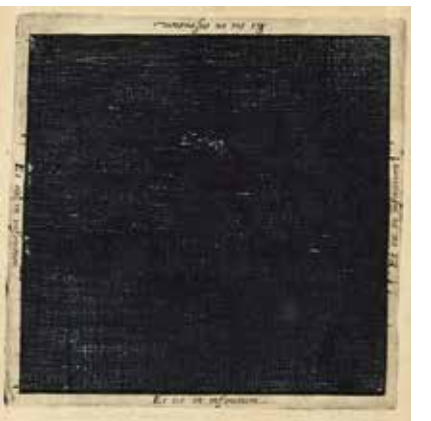
God wielding artist's calipers
Annibal Barlet, *Le vray et methodique cours de la physique resolutive vulgairement dite chymie* (Paris, 1653)

CHAPTER I

ALCHEMICAL GENESIS

INVENTING THE ART OF ARTIFICE IN ANCIENT EGYPT, GREECE, AND CHINA

"And the earth was without form, and void;
and darkness was upon the face of the deep."
Genesis 1:2



Et sic in infinitum ("And so on and so forth …")(detail)
Robert Fludd, *History of the Macro- and Microcosm* (Oppenheim, 1617–21)

ANCIENT ORIGINS

The Book of Watchers—a fragment from the Dead Sea Scrolls found in the Qumran Caves—reveals that alchemy has long been a sexy subject, or at least one tinged by a touch of erotic fantasy:

> Two hundred watchers, angels, sons of heaven, desired the daughters of mortals. So, they shared some secrets in order to seduce them. They taught them how to work the metals of the earth and make gold and silver adornments, prepare glittering beauty-products, precious stones, and color-tints.
> (trans. Matteo Martelli)

The passage also demonstrates the alchemical tendency to link spirituality to art. The text apparently circulated widely among the scientific and studious throughout the Mediterranean. Although originally composed in Aramaic, a ninth-century manuscript preserves a Greek version of this "Tale of the Two Hundred Watchers" by a Byzantine monk from Palestine. It is found in a compilation of texts on χημεία (*chémeia*), a word whose murky etymological origins are still debated among scholars, but is the root of both the words *alchemy* and *chemistry*. And our monk's Greek for "color-tints" is βαφικά (*baphika*), from βαπτίζειν (*baptizein*—to bathe, wash, or baptize).

Whether a source of arousal or not, the Dead Sea—the biblical Hebrews' "Sea of Salt" (Genesis 14:3), known as the Asphalt Sea (*thalatta asphaltités*) to the ancient Greeks because of the tarry black pebbles observed to bubble up from its depths—certainly aroused the curiosity of those with a scientific bent. This chemical pool, charged with ions and percolating mixtures of toxic compounds sprouting mineral crystals, was known since biblical antiquity to yield numerous therapeutic applications for human health. It was one of nature's laboratories, and its murky depths have been analyzed for millennia in attempts to explicate and replicate the interactions of its ingredients and harvest them for human service.

For the ancients, the enigmatic properties of the Dead Sea was a paragon of the many wonders observed in nature, whose potential dangers simply posed tantalizing challenges for the scientific adventurer. How were such concoctions created, and how could their benefits be recreated? For that matter, how did nature nurture growth while it simultaneously engendered death and decay? Did the natural interaction of growth and decay generate a power that produced myriads of transformation, and, if so, how could that "engine of nature" be artificially reproduced through the ingenuity of human artifice? One thing we do know. Providing a synthesis—both in theory and practice—that offered solutions to the basic mysteries of creation was the stimulus for the creation of alchemy.

ANCIENT EGYPT–THE LAND OF KEM

"And when the soul hath departed, a man seeth corruption, and the bones of his body crumble away and become stinking things, and the members decay one after the other, the bones crumble into a helpless mass, and the flesh turneth into foetid liquid …
I am the god Khepri, and my members shall have being everlastingly.
I shall not decay, I shall not rot, I shall not putrefy, I shall not turn into worms, and I shall not see corruption."

"Chapter of Not Letting the Body Perish," *Book of the Dead* (trans. E. A. Wallis Budge)

In ancient Egyptian, the verb *kheper* () means "to come into being, create, become, transform," and its hieroglyphic pictogram was drawn from nature. The Saharan dung or scarab beetle lays its eggs in a pile of excrement and then rolls the mass into a ball, which it buries in the sand. This dung ball functions as a cocoon: Nutrients from the feces feed the growth of the larvae within its sphere and ultimately offer a first meal for the newborn hatchlings.

Ancient Egyptian theologians extrapolated a creation myth from this phenomenon observed in nature. In their cosmology, Khepri, the god who generated the creation of the world, was a divine scarab beetle, who rolled a ball of dung along the river of the underworld by night, from which the Sun hatched every morning. Propelled by the dung-rolling deity, this solar hatchling grew in energy as it wheeled across the sky to its zenith and declined in strength as it descended into the night on its ceaseless revolving path.

Khepri, scarab-god of creation
Pendant from the Tomb of Tutankhamen
c. 1325 BCE

Saharan scarab beetle
rolling its eggs in a ball of dung

Khepri, the scarab-god, might be immortal, incorruptible, and never subject to rot, but the perpetual cycle, which it guided, was driven by a divine impulse to eternally resurrect vitality in the world from the degeneration inherent to mortality. This cosmogonic myth conveyed a simple and obvious parable: Nature literally could turn crap into gold.

THE *KEMISTS* OF KEMET

The motif of life resurrected from death dominated ancient Egyptian art. Analogously, a principal preoccupation of its science was devoted to methods of mummification, a mortal attempt to approximate Khepri's eternal immunity to decay.

The ancient Egyptians' name for their own land was *Kemet*, "the land of *kem*." Egyptologists do not interpret the hieroglyph —*kem* or "black"—ethnically. Instead, the color code signifies the mineral-rich silts deposited along the banks of the Nile's flood plains. And Egyptians were prolific *kem*ists. Red lead, or *minium*, for instance, was used not only to protect living bodies but also to preserve dead ones. It has been found painted on Egyptian mummy wrappings as late as the early Roman imperial period, perhaps doing double duty as decorative colorant and effective repellent against pests. Red lead was a toxic by-product of silver refining. Embalming transformed waste into both medicine to preserve the human body and material for making art to immortalize the memory of human life.

Egyptians involved in the arts also strove to imitate the inventiveness of the dung beetle's ritual of creation by transforming the raw stuff of nature into inventive creative forms. A thriving decorative arts industry was in full swing by the Middle Kingdom (2050–1652 BCE), with artisanal workshops engaged in sophisticated techniques for refining gold, silver, and copper, as well as the production of artificial gemstones, glass, color pigments, and dyes, to feed the demands of fashion for jewelry, cosmetics, architectural ornament, painting, and textiles.

Metallurgists were also deft at methods for mimicking the appearance of gold: By heating copper and mercury, and sprinkling in flakes of gold, the mercury, as it vaporizes, adheres the gold to the copper's surface. The technique, known as "mercury-amalgam gilding," was employed at least as early as the second millennium BCE, and regarded as a highly guarded industrial secret for more than a thousand years. Knowledge of its production was limited only to members of the priesthood.

Goldsmelters keeping a furnace heated (detail)
Mastaba of Mereruka, chief lector-priest and overseer of scribes, of Pharaoh Teti I, ca. 2200 BCE

SYNTHETIC PIGMENTS– EGYPTIAN RED, WHITE, BLACK AND BLUE

Lead did not just preserve the dead. It was a principal ingredient in the glossy black and white eyeliners and mascara worn by the Egyptians. Such lead-based compounds were not found naturally in the region; they were synthetic products of artisanal workshops. Far from suffering from lead poisoning for fashion, Egyptians wore these cosmetic pigments for their medicinal properties: these specific lead compounds stimulate the body's immune defense, protecting the eyes against infection during the marshy season of the Nile flood. Egyptian papyri from the sixteenth century BCE not only offer recipes for lead-based cosmetic medications but also demonstrate that Egyptian chemists were acutely aware of the nuanced chemical properties of lead. Instructions include the caveat that it can be worn topically but is poisonous when ingested.

The earliest known synthetic paint-pigment—that is to say, one artificially synthesized by the deliberate manufacture of a chemical compound—is "Egyptian blue." The Egyptians called it *hsbd-iryt*, or "artificial lapis lazuli," after the mineral prized for its brilliant blue color. The pigment extracted from lapis lazuli is still called ultramarine—from the Latin *ultra mare*, or "beyond the sea." The stone was mined almost exclusively in Afghanistan. An export prized for its rarity, "lapis" was as precious as gold. So, the production of a more cost-effective alternative had a clear, pragmatic appeal to the commercial arts community. Egyptian blue—a synthetic ultramarine pigment—was used as early as the Fourth Dynasty (ca. 2500 BCE) to decorate limestone sculptures and color faience beads.

By the eighth century BCE, Egyptian blue pigment was a favored commodity of Phoenician traders from the Lebanese coast, who presumably spread knowledge about its production throughout the Mediterranean. The Romans knew it as *caeruleum*–our cerulean blue. The use of Egyptian blue seems to have died out in the fourth century CE, its secret recipe presumably lost. This imitation ultramarine blue hue only found a satisfactory substitute with the accidental invention of the first modern synthetic pigment, Prussian (or Berlin) blue in the eighteenth century.

Egyptians applying makeup
Theban Tomb TT52 (Tomb of Nahkt), fifteenth century BCE, Sheikh Abd el-Qurna
The ancient chemists of Kemet also seemed to reap lucrative reward from manufacturing synthetic color pigments, in particular those destined for the cosmetics industry

GREEK ELEMENTS—COLORING WITH DRUGS

A fundamental contribution to the formation of alchemical matter theory was made by the Sicilian Greek philosopher, physician, and poet Empedocles (490–430 BCE). This older contemporary of Socrates is considered the first matter theorist to propose that the natural world was composed of four primal elements—fire, earth, water, and air (and their associative qualities, hot, cold, wet, and dry)—a theory that prevailed well into the European Enlightenment of the eighteenth century.

Tragically, only fragments of epic poems on the scientific nature of creation testify to Empedocles' philosophical worldview. Consider his musings on the basic composition of mortal matter and the processes driving the world:

> First, listen! There are four roots of all things:
> Fire and water and earth and the limitless height of air …
> Just like painters with virtuoso skills and artistic mastery
> dapple up offerings by wielding drugs [φάρμακα / *pharmaka*] of many colors,
> harmoniously mixing more of some, less of others,
> and produce images resembling all manner of things …
> Empedocles, *On [Physical] Nature*

Empedocles uses a botanical term, *rhizomata* ("roots"), as the metaphorical root of his matter theory: the basic stuff of nature stems from four primal elements. His poetic pronouncement was the inspiration for the theory of atomism. Its champion, the Greek philosopher Democritus (ca. 460–ca. 370), claimed that the substance of the four elements was *atomos*, literally "uncut." That is to say, fire, air, earth, and water were each composed of indivisible particles that formed the primal core of all matter.

It was the Athenian philosopher Plato (428/427 or 424/423 – 348/347 BCE) who gave these atoms form. The theory of Platonic solids dictated that the atomic particles of the four elements were geometric: polyhedra ("many sided") with particular shapes. Fire atoms were tetrahedral (four-sided), earth atoms were cubic (six-sided), air atoms octahedron (eight-sided), and water atoms icosahedron (twenty-sided).

ELEMENT	SYMBOL	"ATOMIC" SHAPE
Earth		Cube 
Water		Icosahedron 
Air		Octahedron 
Fire		Tetrahedron 

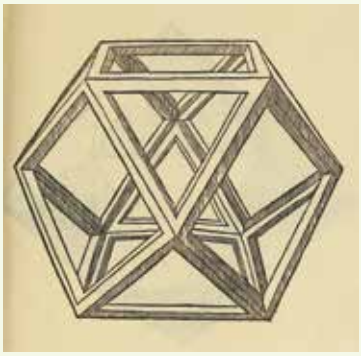
Plato's thesis probably owed much to the mathematical mysticism of Pythagoras and his theorems, but Plato gave definition to these building blocks of the physical world. Plato also began to ponder what his student Aristotle ultimately proposed: the existence of a fifth element—aether, the stuff of which the heavens were composed—assigning it the "atomic" shape of the 12-sided dodecahedron. These forms, the so-called Platonic solids, offer a mathematical model for envisioning the building blocks of the cosmos—and an artistic method for visualizing them.

The subsequent introduction of geometry by the Greco-Egyptian mathematician Euclid of Alexandria (fl. 300 BCE) provided the means to visually calculate and artistically render the physical surfaces of a material world. It is no coincidence that the seminal work of Euclidean geometry is titled *Euclid's Elements*!

Two art objects in different media—spanning 1,500 years—display the persistent artistic obsession with the elemental world. A rock-crystal icosahedron representing a water atom was found in the tomb of a young girl and perhaps was placed there as a token of her journey through the river of the Underworld.

Geometrically mapping the physical world with the Platonic solids paved the way for Renaissance concepts of perspectival rendering of three-dimensional objects onto a two-dimensional plane, as depicted by Leonardo da Vinci in Luca Pacioli's *Divina Proportione* (Divine Proportion).

Rock-crystal icosahedron
representing a water atom
North of Rome, ca. first century CE



Leonardo da Vinci, woodcut illustration
of a hollow icosahedron (water atom)
Luca Pacioli, *Divina Proportione* (Venice, 1509)

GREASY GREEK GEOMETRY– STICKY SKINS, SLIPPERY SURFACES, AND OTHER SLICK STUFF

What, however, were the mechanics behind the bonding of these elements, beyond Empedocles' poetic metaphor of the natural urge of plant roots to intertwine in harmonious growth like the blending of paints? It was Aristotle (384–322 BCE) who grappled with a unified theory to resolve the physics and metaphysics of the forces that drive the universe and give it coherence: They were Soul and Spirit. Aristotle hypothesized that all nature is imbued with a soul—*psyché* (ψυχή in Greek; *anima* in Latin)—that animates matter. He furthermore identified the physical manifestation of this World-Soul: *pneuma* (πνεῦμα in Greek; the Latin is *spiritūs*—"breath"). This *pneuma* is a tangible force, which breathes life into all things and literally functions as a pneumatic engine, generating energy in the world, and animating all life with the spirit of the World-Soul's divine breath.

So much for a coherent unified theory of matter. How did physical matter cohere? You can mix water and earth, and make mud, but it is temporary. The bond between wet and dry will inexorably dissipate into dirt. But what of viscous fluids such as olive oil, pitch, or, for that matter, the tar that bubbled up from the depths of the Asphalt Sea? Not to mention the quixotic quirks of quicksilver—the liquid metal mercury. What was the root cause of their viscosity, this curiously unctuous nature that maintained the fluidity of a liquid state (i.e., the element of water), while retaining the cohesiveness of a solid (earth)? How did such substances sustain a slippery stability without degenerating and disintegrating into separate constituent elements?

By way of explanation, Aristotle offered the "sticky skin" theory and dredged up the obscure Greek word γλίσχρος (*glischros*) to make the theory stick. Apparently a compound of *glis*—sticky, clingy, slippery, gluey, glutinous–and *chros*—derived from *chroa*—skin or surface. The term is, in fact, adapted from Plato, who argued that flesh is bound to sinew and bone by a glutinous and fatty matter that enables the body to stick together and grow elastically as a single coherent entity. (Here's a fact: Our word "elastic" is derived from *elaion*—Greek for olive oil.) Plato introduces the concept of "unctuous moisture" in the *Timaeus*, the same dialogue in which he broaches the theory of the so-called Platonic solids. Aristotle posited that all the surfaces of these multifaceted particles are, in a sense, smeared with more or less of this *glischros*—sticky skin or slippery surface—which affects the cohesive ability of any substance to bond with another. Here lies the core of alchemical matter theory. Manipulating the sticky and the slick is the key to controlling the bonding of a substance and its form—and thus the transmutation of matter.

>
God as glassblower:
Aided by the four elements, the globe is inflated
and infused with pneumatic spirit.
Achille Bocchi, *Symbolic Questions about the Universe …* (Bologna, 1555)


ורוח אלהים מרחפת על פני המים׃

Alexander's napalm
The Iron Cavalry of Al-Iskandar (Alexander) battles King Fur of Sind (India)
Shahnama (Book of Kings), Iran, ca. 1330–40, painted and gilt with synthetic pigments

Alexander's "Iron Cavalry" were not human charioteers. They were hollow iron shells which "inflicted terrible damage with missiles of naphtha gushing from mechanical devices. This *pharmakon* is an asphalt-derivative, and is so thoroughly flammable that it completely engulfs in flames whomever and whatever it adheres to, nor is it easily extinguished by any amount of water."
Dio Cassius (155–235 CE), *Historia Romana*

ALCHEMY AFTER ALEXANDER

Aristotle's most famous student was, of course, Alexander the Great (356–323 BCE), whose conquest of Egypt, the Persian Empire, and parts of the Indian subcontinent carried in its train the propaganda of uniting the known world into a Hellenistic vision of global order. His incursions into Africa and Asia eventually transformed a series of foreign clashes into an enduring intellectual exchange of immense impact to transcultural history.

Upon Alexander's death, his general and successor as dynastic ruler of Egypt, Ptolemy I (367–283 BCE), or perhaps his son, Ptolemy II (308–246 BCE), established in his namesake city of Alexandria the *Mousaion,* a temple to the Muses (and the root of the modern museum, both in word and spirit). Better known as the Library of Alexandria, this research center of global knowledge collected from the reaches of Alexander's empire became the haunt of such scholars as the "father" of geometry, Euclid of Alexandria (325–265 BCE), and the astronomer Ptolemy (ca. 100 – ca. 70 CE), whose star charts continued to carry authority throughout the so-called "Age of Discovery" in sixteenth-century Europe.

ROMAN REFINEMENTS

"Having thoroughly reviewed the human ingenuity for making art reproduce nature, one cannot but marvel that there is next to nothing that cannot be perfected by means of fire. It melts sand into glass, [minerals into] pigments and drugs. Fire smelts ore into copper, … purifies gold, and incinerates stones to dust used as cements to bond the building blocks of construction …"

Pliny, *Natural History*

During the Roman imperial occupation of Egypt, Greek natural philosophy progressively melded with Egyptian mythology, medicine, and metallurgy. In the ensuing centuries, the cultural legacies of the two civilizations merged in the land of *Kem*, first in the shadow of Alexander the Great's campaign of conquest and then under the rule of the Romans.

Pliny the Elder's (23/24–79 CE) encyclopedic *Natural History* was the scholarly beneficiary of the expansionist Roman Empire. To the east, its forces followed in the footsteps of Alexander the Great, effectively annexing much of his empire. Western campaigns extended the Roman Empire to the Atlantic coast. Pliny's numerous references to exotic products in faraway lands demonstrate the ample supply of global sources to which he had access for his research into the natural world. His globalized encyclopedia of natural history views the world through a lens focused on its natural resources, consistently emphasizing the variety of ways that the human knack for *techné* (in Latin, *ars*—art or artifice) can manipulate and transform the world's raw materials into commodities both beneficial and profitable to humankind.