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Signs and symbols in Kircher's Mundus Subterraneus

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ABSTRACT

Symbolism, allegory, and metaphor pervade Athanasius Kircher's (1602–1680) *Mundus Subterraneus* (*The Subterranean World*). Elements from the communicative theory of semiotics are useful for exploring *Mundus Subterraneus* and for illuminating the modern reactions to his works. Kircher used Hermetic and Neoplatonic philosophies as a bridge between medieval thought systems and the growing empirical movement of the Scientific Revolution. In Kircher's studies, no event was taken in isolation, and his examination of the earth rested with Plato's philosophy that the world was created by God as a manifestation of his own perfection. From a modern semiotic viewpoint, Kircher used indexical and iconic signs to combine rational and empirical techniques that sustained his holistic view of the cosmos. In the modern ideal formulation of scientific observation and inquiry, indexical signs are acceptable authoritative causal links between observation and interpretation. For Kircher, both indexical and iconic signs were legitimate articles to collect and employ because they were all manifestations of the Divine Mind. Iconic signs could be religious images or conceptual ideas that Kircher projects onto the workings of the earth.

Keywords: history of geology, Baroque science, Athanasius Kircher, semiotics, Hermeticism.

Indeed there is nothing, actually produced by nature ... that will not be seen by our imagination as similar to something of human concern.

—From Kircher's *Mundus Subterraneus* (1665)

“THE PRESENT IS NOT THE KEY TO THE HISTORICAL PAST”

While James Hutton's (1726–1797) axiom that “understanding present forces is the key to interpreting Earth's past” is a basis of modern geologic studies, no inclination can be more misleading to historical analysis than our temptation to project modern sensibilities onto older methods and practices of geoscience (Gould 2004). A case in point is the few geologic

examinations of Athanasius Kircher (1602–1680). Kircher, a politically influential German Jesuit, occultist, and polymath (Fig. 1) working at the cusp of the Enlightenment, has been consistently identified as a curious footnote to the conventional portrayal of the linear advancement of the earth sciences (Gould, 2004). This established account posits that through the Scientific Revolution, science gradually removed religious obstructions and revolted against the dominance of Aristotelian doctrine (Reilly, 1974). In turn, science moved toward a realization of the immensity of time and the inner workings of our planet. Certainly, some of Kircher's methods may seem foreign

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P. ATHANASIVS KIRCHERVS FVLDENSI
 è Societ: Iesu Anno ætatis LIII.

Honoris et observantiæ ergò sculpsit et D.D. C. Bloemaert Romæ 2 Mayi A. 1655.

Figure 1. Portrait of Athanasius Kircher (1602–1680) by Cornelius Bloemart (1603–1680) from the 1664 edition of *Mundus Subterraneus*.

to modern readers, and some of his conclusions are flatly incorrect. However, conventional accounts of the progression of earth science rarely take into account contributions of men such as Kircher. Beyond his inclusion in historical surveys of the earth sciences, there have only been a few investigations of Kircher's geological work (see Baldwin, 1993; Leinkauf, 1993; Nummedal, 2001; Waddell, 2006) and even fewer from a geologist's perspective (see Gould, 2004).

Kircher's investigations of the earth in his immense two-volume tome, *Mundus Subterraneus* (1664–1665) are replete with an astounding and strange variety of subjects, including astrology, volcanoes, alchemy, mining, dragons, weather, eclipses, fossils, and gravity (Godwin 1978). Peculiar to the ears and eyes of modern practitioners of geology, Kircher often calls upon religious and hermetic philosophies in his interpretations of the subterranean world. Yet, he also presents experimental observations throughout his treatise, and, like Pliny before him, he saw the need to lower

himself into the crater of Mount Vesuvius for closer observation immediately before its eruption in 1638 (Fig. 2).

This paper examines the cultural influences on Kircher and his use of symbolism in *Mundus Subterraneus* to communicate his ideas and observations about the earth. Modern explanative theories such as semiotics, the study of signs and their meaning, suggest that an understanding of cultural environment, historical context, and external influences is essential to begin to extract original meaning from an historical text or analysis. This paper will demonstrate that elements from semiotics are quite useful to interpret Kircher's discussions of the earth. We begin with a discussion of the historical context and philosophical influences on Kircher and continue with application of semiotics to *Mundus Subterraneus* (1664, 1665).

ATHANASIVS KIRCHER AND *MUNDUS SUBTERRANEUS*: TWO ANOMALOUS ENTITIES

Athanasius Kircher's life spanned most of the seventeenth century, and, as such, his career bridged a changing society. Early in his career, the polymath's tendencies toward generalization and integrated studies were accepted, even praised, in the learned community (Findlen, 2004). Kircher was a respected, if controversial, contemporary of Johannes Kepler, Robert Boyle, and Isaac Newton, all of which maintained an interest in Hermeticism, Neoplatonism, and alchemy. Scientific research during Kircher's early career still incorporated mystical thought and philosophy. As Godwin (1978, p. 5) states, the purpose of examinations of the universe at that time "was nothing less than to penetrate the workings of the Divine Mind." However, by the latter half of the 1600s, Kircher's intellectual authority began to decline as his academic peers turned toward specialization as the preferred path to knowledge (Findlen, 2004). This period also saw the shift from religious-based interpretations to observational and empirical interpretations. While philosophical divisions appeared between objective examinations of the physical world and subjective interpretations of mind and thought, Kircher maintained his holistic worldview of an integrated physical and spiritual universe. Throughout his discussions of the earth, Kircher uses sign, symbol, analogy, allegory, and even dream-states as mechanisms for conveying his interpretations of the world. These permitted him to maintain the philosophical association between the physical and spiritual world.

The *Mundus Subterraneus* (Fig. 3) was arguably the most popular of Kircher's works in his day. By the time of its printing in 1664 and 1665, Kircher had become famous among learned men across Europe and even the New World. With a career that would eventually include over 40 books under his name, by the time of *Mundus*, Kircher was a publishing machine, and his influence reached both the common man and the growing academic community. References to his works are found in the writings and correspondence by many of the great contemporary scientists, including Martin Lister (1639–1712), Robert Moray (1608?–1673), Baruch Spinoza (1632–1677), John

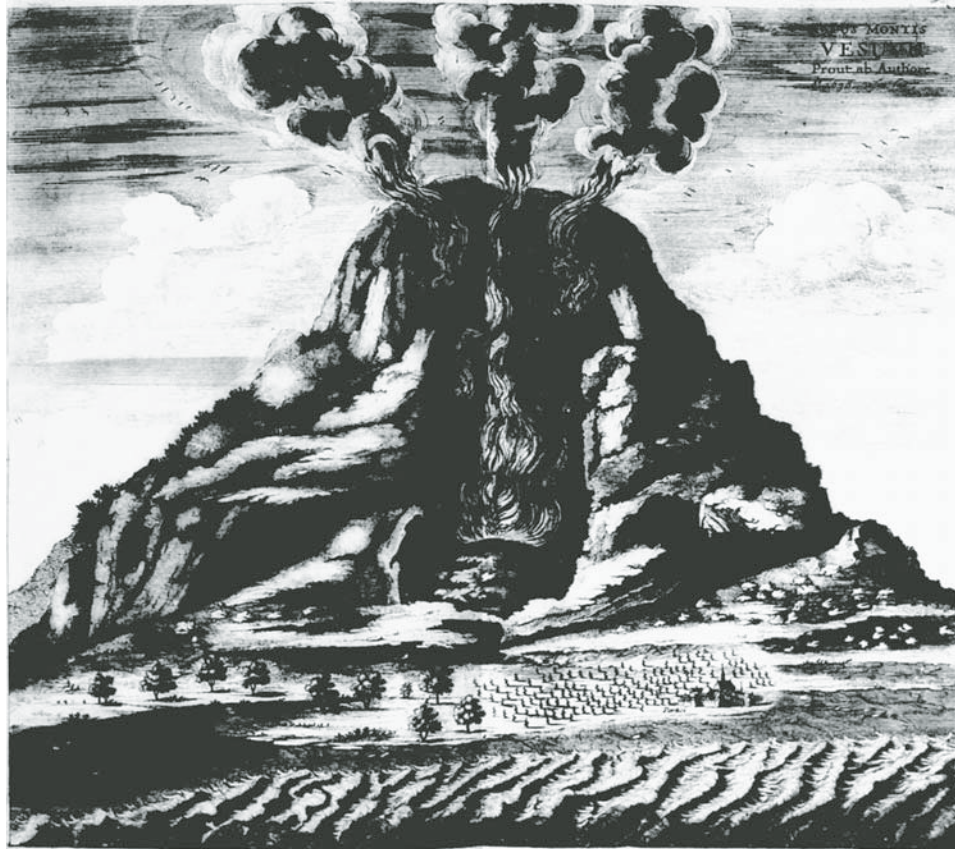


Figure 2. Engraving of the eruption of Mount Vesuvius in 1638. From *Mundus Subterraneus* (2nd edition, 1678).

Locke (1632–1704), Henry Oldenburg (1618–1677), Nicolas Steno (1638–1686), Christian Huygens (1629–1695), Gottfried Leibnitz (1646–1716), Robert Boyle (1627–1691), and Rene Descartes (1596–1650).

As with Kircher, the *Mundus Subterraneus* has been a problematic work for historians to fit into the traditional description of the evolution of the earth sciences. Godwin (1978) describes the work as “a textbook in general science...[which] does not broach new frontiers of knowledge but proffers its information in a readable and lavishly illustrated form, free from mathematical and philosophical complexities.” (Godwin, 1978, p. 84). Oldroyd (1996) considered the work to be a reflection of “what the seventeenth-century man in the street may have thought of the Earth’s interior.” According to Oldroyd, it “gave expression to the beliefs of his day, and in his illustrations he reveals what many sixteenth- and seventeenth-century writers thought was going on in the Earth’s interior.” (Oldroyd, 1996, p. 36). However, most of *Mundus Subterraneus* has never been translated into English (Fig. 4) from its original Latin (1665, 1678) editions or Dutch (1682) versions. The majority of analyses of the work from an English perspective have therefore focused on the “lavish” illustrations and have not tackled the accompanying 800+ pages of text. The text and accompanying images are

actually extremely complex in their philosophical, experimental, and theological treatment of the earth.

The *Mundus Subterraneus* represents a philosophical bridge between medieval thought systems and the growing empirical movement, which we today, in retrospect, regard as the Scientific Revolution. Kircher used a sophisticated combination of theological and empirical techniques that sustained his holistic view of the earth. It is interesting and significant to note that Kircher’s works related to the earth proved controversial to his contemporaries on both sides of the growing theological-secular divide. Of all his published works, the only volume disapproved of by Jesuit censors on philosophical grounds was the precursor to *Mundus* and his first geological manuscript, *Iter Exstaticum II* (1657) (Fig. 5). Some of his other works did face Jesuit scrutiny, but it was focused on the quality and style in *Ars magna sciendi* (1631) and factual inaccuracies in *Iter Hetruscum* (1661) (Siebert, 2004). The *Iter Exstaticum II* was itself an expansion of an earlier work, *Itinerarium exstaticum* (1655), which discussed the cosmology of the universe above Earth and presented the discussion in a fictional dream-state, possibly as a means to get past Jesuit censors (Rowland, 2004). The subsequent *Iter Exstaticum II* added discussion of the structure and workings of Earth. These additions proved problematic for one particular Jesuit censor, who argued

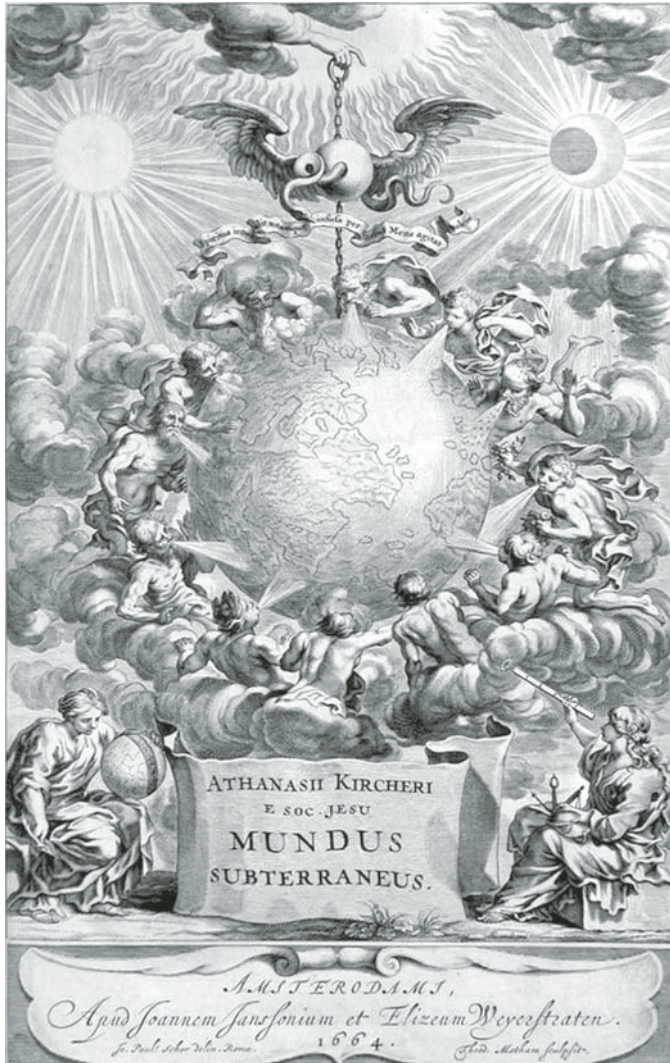


Figure 3. The frontispiece of *Mundus Subterraneus* (2nd edition, 1678) illustrates the influences of hermetic and Roman Catholic principles on Earth. At the top of the image, God's hand sustains Earth through the influence of the Trinity (the winged sphere penetrated by the serpent). The serpent holds a banner with the quotation from Virgil's *Aeneid* that reads, "The Spirit supports from within infused through its every member, Mind sets mass in motion and mingles itself with the mighty body." Earth hangs between the opposing hermetic principles of the Sun and Moon (see text for explanation). Earth is also surrounded by the twelve winds (an allusion to the influence of the twelve signs of the Zodiac). At the base of the illustration, two figures represent man's attempts to measure and understand the terrestrial world (on the left) and heavens (on the right).

that Kircher was boastful and disobedient, incorrectly explaining the motion of the seas and using various philosophical arguments that contradicted Aristotle's authoritative view of the natural world (Siebert, 2004). Kircher opposed the teaching of Holy Writ in the book of Ecclesiastes by denying that springs and rivers originate in the sea. Instead, Kircher asserts that springs and rivers are produced only by the condensation of air into vapor.

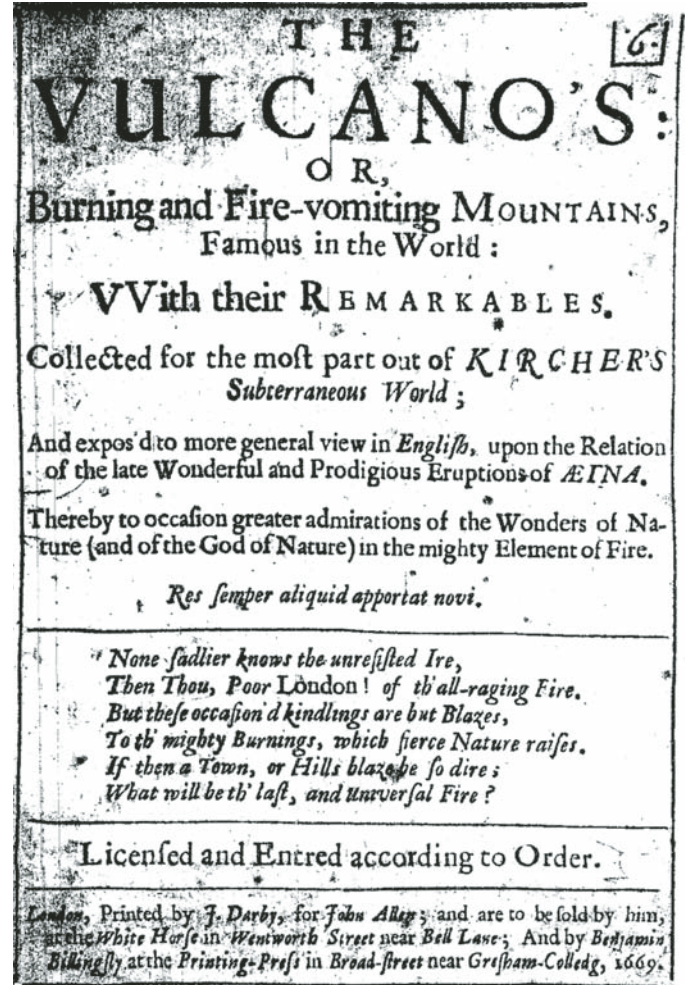


Figure 4. Title page from the partial English translation ("The Vulcanos..." 1669) of portions of Kircher's work dealing with volcanoes. This English text only includes parts of Kircher's work dealing with volcanoes. The title page also refers to the recent fire of London of 1666 and was probably a means to draw interest in the work.

Kircher's secular contemporaries also took issue with *Mundus*. For example, Steno did not agree with Kircher's position that mountain chains can be categorized based on geographic orientation. While Kircher distinguishes a series of east to west chains crossed by a very high north to south belt, Steno recognized three types of mountains based on mechanical processes (Adams, 1938).

HERMETIC INFLUENCES ON KIRCHER'S "GEOCOSM"

Of the many influences on Kircher, two are of particular significance to his geologic analyses: Roman Catholicism and Hermeticism. While it is assumed that the modern reader understands the essentials of Catholic doctrine, the same cannot be assumed of Hermeticism, and so it should be described in brief.

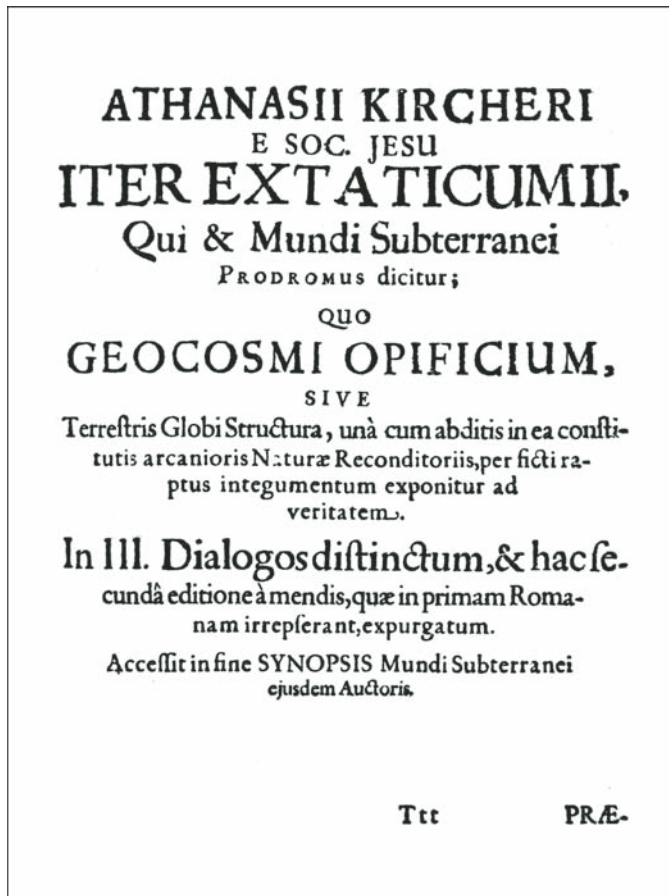


Figure 5. Title page from *Iter Extaticum II* (1657), a work that proved problematic to Jesuit censors on the basis that Kircher's interpretation of Earth contradicted Aristotle's authoritative view of the natural world. This work became the prelude for *Mundus Subterraneus*.

Historical surveys of the earth sciences have often mentioned the influence of Neoplatonism and alchemy in Kircher's geological and paleontological work, but references to Hermetic philosophy are usually made only to degrade, demean, or dismiss a particular conclusion or method. These are unfortunate and unconstructive assertions. By employing Hermeticism, Kircher attempted to understand the earth using "naturalistic" explanations while maintaining a holistic religious system of correspondences.

A powerful philosophical force in the Renaissance, Hermeticism and its related philosophies of alchemy and Neoplatonism, have today become a symbol of medieval and superstitious practices. Hermeticism is a set of philosophical and religious beliefs based upon writings attributed to Hermes Trismegistus, a fusion of the classical Greek god Hermes and the ancient Egyptian god Thoth. While elements of Hermetic doctrine were known in the Middle Ages through the work entitled *Asclepius*, Hermeticism was broadly reintroduced to the West in 1460 CE, when a monk named Leonardo di Pistoia brought the *Corpus Hermeticum* to Pistoia, Italy. Subsequently translated by Marsilio Ficino, the

Corpus Hermeticum is a set of 16 books set up as dialogues between Hermes and a series of personages.

A related Hermetic work, *The Emerald Tablet* of Hermes Trismegistus, is a short tract that includes the well-known dictum "As above, so below." This statement of correspondence became the mantra for a holistic philosophy that could be, at least in part, accommodated within a Christian worldview. The so-called Tablet became a foundation of medieval and Renaissance alchemy. Commentaries and/or translations were published by, among others, Roger Bacon, Michael Maier, Albertus Magnus, and Isaac Newton.

Ficino and the other Renaissance scholars who studied the Hermetic texts accepted the ancient historical provenance claimed within the *Hermetica*. Encouraged by Church authorities, these scholars believed that Hermetic philosophy was an ancient forerunner, possibly Egyptian in origin, and prophetic of Christianity. The influence of these works should not be underestimated (Yates, 1966). Copernicus, when introducing the heliocentric hypothesis, quotes the words of Hermes Trismegistus from the *Asclepius* when he states:

For, the sun is not inappropriately called by some people the lantern of the universe, its mind by others, and its ruler by still others. [Hermes] the Thrice Greatest labels it a visible god, and Sophocles' Electra, the all-seeing. Thus indeed, as though seated on a royal throne, the sun governs the family of planets revolving around it. Moreover, the earth is not deprived of the moon's attendance. On the contrary, as Aristotle says in a work on animal, the moon has the closest kinship with the earth. Meanwhile the earth has intercourse with the sun, and is impregnated for its yearly parturition.

—From Copernicus (1543, Chapter 10)

Giordano Bruno (1548–1600), in defense of his ideas of the movement of Earth, adapted the view discussed in the *Corpus Hermeticum* that Earth is not immobile because it is alive (Yates, 1966):

Hermes: After all, what is the energy of life? Is it not movement? What, then in the cosmos is unmoving? Nothing, my son.

Tat: Does the earth seem to you unmoving, father?

Hermes: No, my son. It is the only thing full of movement, and at the same time stationary. Would it not be absurd for the nourisher of all things, the producer of and begetter of all, to be motionless? It is impossible for one who brings forth to do so without movement. It is most absurd to ask whether the fourth element earth is idle, for an unmoving body signifies nothing but idleness.

Then know, my son, that without exception everything in the cosmos this is, is moving, whether decreasing or increasing, and that which moves is alive.

—Translation from Salaman et al. (2000, p. 63)

Even James Hutton, in the last part of the eighteenth century, wrote his doctoral dissertation on the circulation of blood in the microcosm, reflecting the persistent Hermetic principle that man, the microcosm, reproduces in miniature, or is directly influenced by, events of the macrocosm (Eisely, 1960).

However, by the early seventeenth century, Hermeticism had begun to lose its widespread appeal. Subsequent analysis of

Hermetic texts claimed that the extant Hermetic writings were not the work of an ancient Egyptian priest but were in fact dated to the early Christian era (Quispel, 2000). After this reevaluation, the *Corpus Hermeticum* began to fall out of favor.

Kircher, working in the waning years of the Hermetic revival, borrowed ideas from alchemic and Neoplatonic philosophies when emphasizing his holistic approach. In Kircher's studies, no event is taken in isolation. Behind Kircher's examination of Earth rests Plato's philosophy that the universe or great world order was fashioned by God the creator as a manifestation and illustration of his own perfection: "and so he formed it as a single visible living thing which was to include all related creatures ... by turning it he shaped it into a sphere ..., giving it the most perfect form of all" (from Plato's *Timaeus* in Roob, 2006, p. 35). In sacred geometry, the sphere is the ultimate expression of unity, completeness, and integrity. In the sphere, there is no reference point given greater or lesser importance, and all points on the surface are equally accessible and regarded by the center from which all originate. From the second chapter of *Mundus*, Leinkauf (1993) recognized that in order to maintain the Church's doctrine of the geocentric position of Earth and the finiteness of the universe, Kircher cleverly describes the subterranean world as an analog for the greater universe itself, where God is the nondimensional center (or punctum) of the cosmic reality, and Earth represents the absolute perfect and finite geometric structure (the sphere). By manipulating the ambiguity of the word *mundus*, Kircher could refer to either Earth as an isolated planetary body, or the whole cosmos (Rowland, 2004). Kircher also uses the terms "geocosm" and "geocosmos" in this bimodal fashion.

In studies of alchemic practices of the Jesuits in the seventeenth century, Baldwin (1993) acknowledged the influence of alchemy on Kircher's interpretation of Earth. She states that Kircher maintained that the geocosm was the prototype for alchemical processes and that careful observation of geological events could teach alchemists the perfection of their art. From a geologic perspective, it can also be argued that throughout the *Mundus*, Kircher used descriptions of alchemic laboratories and processes (which he actively practiced) as analogs for an interpretation of the earth. In this way, his techniques can be seen as a precursor to the use of modern analogs for interpretation of ancient earth processes. Instead of "the present is the key to Earth's past," Kircher's interpretive maxim could be, "the modern laboratory is the key to Earth's past." The various alchemic techniques of heating, evaporating, calcining, coagulating, hardening, and fixating could be used as conceptual models for understanding the formation of Earth. He had ascended Vesuvius in 1638 and had himself lowered inside its crater. Escaping the wrath of Vesuvius, a few days later he witnessed the volcanic eruption from fifty miles away. His observations were interpreted within his circle of influence. He likened the volcano's heat to that of the alchemist's furnace, its smoke to that of his alchemical concoctions, and its stench to the sulfur and bitumen fumes, which he inhaled in his laboratory (Baldwin, 1993).

Kircher's comparison of the workings of Earth to an alchemic project largely focuses on the opposing principles of fire and water. Astrologically, the Sun and the Moon represent these elements and signify two opposing principles. The Sun represents fire, sophic sulfur, God, the King, Spirit, and ultimately the One Mind of the universe. The Moon represents water, sophic salt, the Queen, the Holy Ghost, Soul, and ultimately the One Thing of the universe. It is indeed interesting to note that the Sun and Moon are the only two heavenly bodies described in detail other than Earth in *Mundus Subterraneus*. In fact, individual chapters are devoted to these objects.

At the microcosmic scale, the alchemic principles of fire and water were used as a philosophical foundation for understanding eruptions of volcanoes. From observations along the Apennine Peninsula, Kircher notes that the oceans tend to recede and then rise in relation to ensuing volcanic eruptions. He draws an association between the two events and explains their correspondence through the important Hermetic principle of maintaining equilibrium between fire (volcanoes) and water (the ocean). Kircher describes the oceans filling in subterranean voids left behind by escaping fires that feed volcanoes and, hence, extinguishing the eruptions.

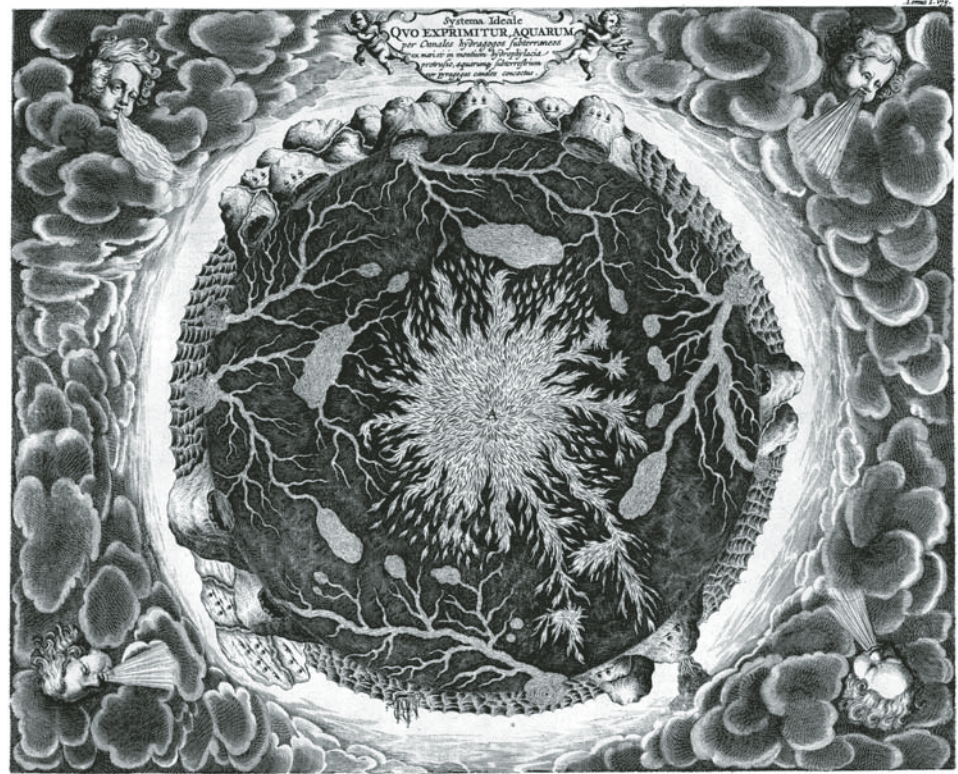
Equilibrium of fire and water is also used at a macrocosmic scale. Through the conjunction of these two primordial elements, Earth becomes the perfect spherical eunuch (Fig. 6). Citing elements from alchemy, sacred geometry, and Catholic theology, Kircher's spherical geocosm is described in terms of a living castrated being. As a spherical eunuch, Earth becomes a metaphor for perfect neutrality and the neutral stage in all reality for mankind to exist (Leinkauf, 1993).

SIGNS IN *MUNDUS SUBTERRANEUS*

Semiotics is the study of signs and how meaning arises by the heuristic process of perceiving and conceiving objects. This explanative theory is useful for exploring Kircher's interpretations and is also useful for illuminating the modern reactions to his works. We can approach *Mundus* with semiotics by examining how Kircher recognized and interpreted various natural signs. In the most elementary terms, signs can be defined as something present that represents something absent (Leeds-Hurwitz, 1993). In semiotics, a sign is a set of characteristics that represents an object to somebody in some capacity. Characteristics of an object govern what sign or signs are recognized. In turn, a sign creates in the mind of a person an equivalent or more developed sign or idea, the interpretant (Chandler, 2007).

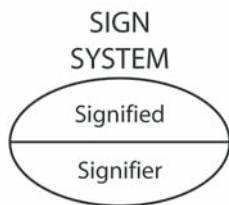
Two conceptual models dominate the modern study of semiotics. Figure 7A illustrates the Saussurean dyadic sign model, termed "signification." The Swiss linguist Ferdinand de Saussure (1857–1913) organized the formulation of meaning as a relationship between a "signifier" and a "signified concept." The "signifier" is commonly interpreted as the physical form of a sign, that is, something which can be perceived by our senses. The "signified" is the mental conception of the meaning of the sign.

Figure 6. Kircher's interpretation of the interweaving of fire and water in the subterranean world. This was a reflex-spherical eunuch.



Ignis centrali A. undiq; et undiq; per pyrragoei canales exhalationes spiritusq; ignea diffundit: ha hydrophylacia impacta, partim in thermas disponit-partim in vapores attenuat: qui concavorum antrorum fornicibus illius, frigore loci condensati in aquas demum, resalub fontus rivores generant: partim in alia divozorum microrum rucos factas matricas derivat: in metallica corpora coalescent, aut in novam combustibile materia facturam ad ignis nutrimentum destinantur. Vidi hic quop quomodo Mare vocis et aere profunde, vel ghaumtum, aquas per-subterraneos cuniculos in altissima montium hydrophylacia gasculetur. Sed Figura te melius docebit: omnia, quam ego pistoribus verbis non capiam. Vidi quop subterraneum orbem, in octava superficie terre mare campay subtequi, et hae aircum ubi schema docet: Reliqua sciatius ac ipse operi descriptioni et rationis patebunt.

A. Saussure's Dyadic Sign Model

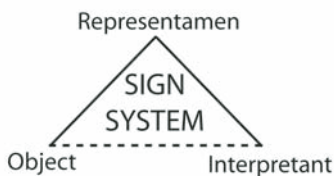


SAUSSURE'S DYADIC SEMIOTIC ELEMENTS

Signifier: the form that the sign takes
Signified: the concept the sign represents

**Note: the Saussure model does not have an equivalent to Peirce's "object."*

B. Peirce's Triadic Sign Model



PEIRCE'S TRIADIC SEMIOTIC ELEMENTS

Object: an item identified by an understood common, shared characterization or classification

Representamen (Sign): something which stands to somebody for something in some respect or capacity; the form that the sign takes (loosely equivalent to Saussure's "signifier")

Interpretant: the concept the sign represents or the implication of the sign; loosely equivalent to Saussure's "signified"; creates in the mind of that person an equivalent sign, or perhaps a more developed sign

Figure 7. The two principal sign system models found in modern semiotics. The upper diagram (A) illustrates the Saussurean dyadic sign model, termed "signification." Here, the sign system is a formulation of meaning as a relationship between a "signifier" and a "signified concept." The "signifier" is the form that the sign takes and is something perceived by our senses. The "signified" is the mental conception of the meaning of the sign. The lower diagram (B) demonstrates the Peircean triadic sign system model. This model posits three elements: an object, a representamen, and an interpretant. An object is an item identified by an understood common, shared characterization or classification. The representamen is a characteristic that signifies something in a particular capacity. The interpretant is the conception or implication of the sign.

Figure 7B demonstrates the Peircean triadic sign system model. The American philosopher Charles Peirce (1839–1914) distinguished three elements within his derivation of a sign model: an object, an representamen, and an interpretant. The “object” is what a sign stands for (or represents). The sign itself (or “representamen”) is what is perceived by our senses. The “interpretant” is the mental conception of the sign. The interpretant then becomes itself a sign in the mind of the interpreter.

A sign system may be perceived and conceived in three aspects: (1) symbolically, (2) indexically, or (3) iconically. A *symbolic sign* is one that does not bear a resemblance to its object and therefore its relationship must be learnt. Examples of symbolic signs include languages, letters, numbers, and map symbols. Conversely, an *indexical sign* is physically or causally connected to the object. Examples of indexical signs include medical symptoms, natural events, measuring instruments, and video or audio recordings. An indexical association can be observed or inferred. An *iconic sign* is perceived as resembling or imitating the object being similar in possessing some of its qualities. Iconic signs include portraits, scale-models, metaphors, and imitative gestures (Chandler, 2007).

As discussed already, Kircher’s method of understanding Earth was founded on upholding a coherent, logical system while sustaining the Hermetic macrocosm-microcosm tradition, which maintains Christian theology and the philosophy that supported it. These two principles profoundly influenced Kircher’s perception of signs and the meaning attributed to them.

In the earth sciences, Kircher is remembered in a large part for misidentifying fossils and their origins (Fig. 8). Kircher’s examination of figured stones were formed through sign recognition (textures, familiar images, etc.) that was influenced by the Christian and Hermetic traditions. In some cases, Kircher recognized the figures as actual remains of organisms. In other cases, the images were perceived to simply “look” like organisms. (Gould [2004] suggested that these probably were, in fact, molds of fossils.) Some of the stone figures were even identified as representing religious images. What is important to note is that in each of these cases, Kircher’s interpretations of stones were directly related to whether he perceived their characteristics as *indexical* or *iconic* of the object. Kircher’s recognition of religious imagery and figured stones “resembling” fossils are classic example of iconic signs. The stones resemble religious figures or possess some of the qualities of petrified organisms but are not the actual object of reference. Since Kircher saw the sign itself as simply imitating the object and not the object itself, he showed little concern for how these signs actually appear on stones. For him, the ultimate purpose of understanding the natural world was to understand the Divine Mind. This disregard for causality has led modern scientific historians to question his methods. Most modern practitioners of geology are, however, familiar with Kircher’s acknowledgment that some stone images result from the preservation of previously living organisms. Kircher states, “I will not speak here of the innumerable oysters, clams, snails, fungi, algae and other denizens of the sea that have been converted to stone, because

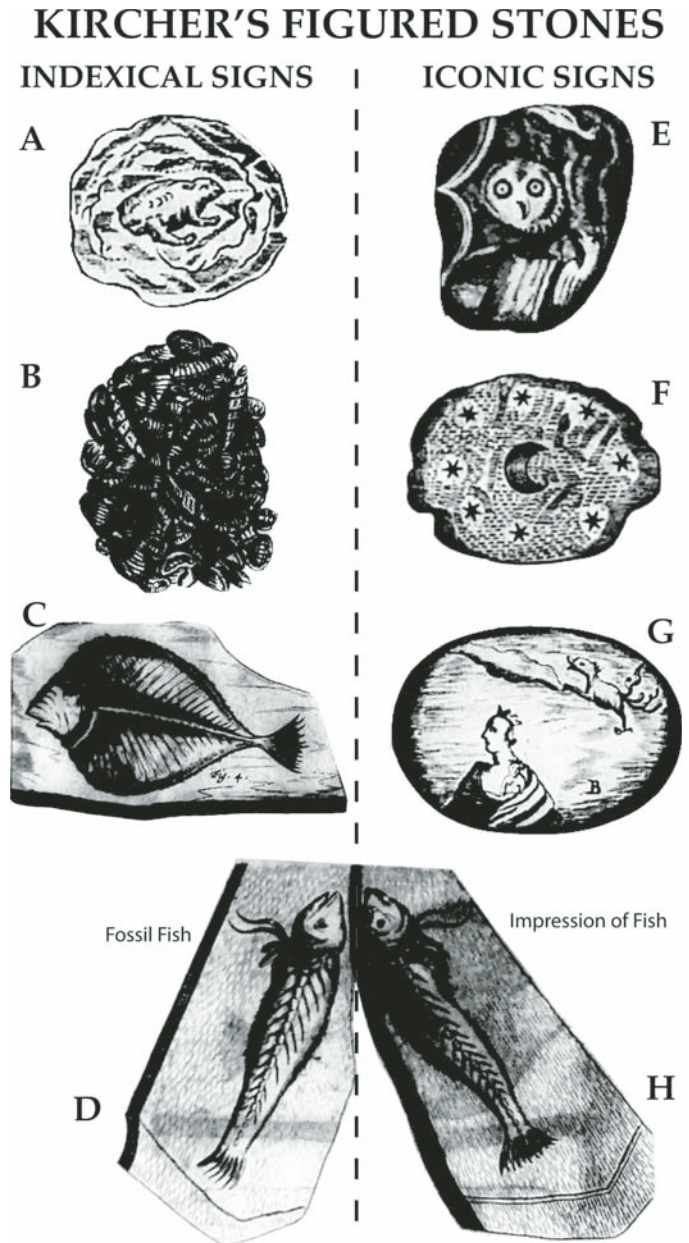


Figure 8. Examples of Kircher’s use of iconic and indexical signs as illustrated in *Mundus Subterraneus*. (A–D) Examples of use of indexical signs. (A) Toad within a stone that corresponds to the ancient thought that just as stones grow in Earth’s “body,” stones may grow in animals’ bodies, such as toads. (B) A cemented collection of shells that represents Kircher’s position that “innumerable oysters, clams, snails, fungi, algae and other denizens of the sea that have been converted to stone.” (C–D) Engravings of objects that Kircher recognized as petrified remains of fish. (E–H) Images that Kircher interpreted as iconic signs, including animals (an owl in E and a fish in H), astronomical objects (the Moon and fixed stars in F), and religious/mythologic objects (the Virgin and Child with dragon in G).

these are obviously found everywhere in such a state, and hardly merit any mention" (translation by Gould, 2004). Such interpretations are indexical signs, where the sign is not arbitrary but directly connected in some way (physically or causally) to the object. A causal link is made between the sign and object. It is in the use of these indexical signs that Kircher's interpretations parallel modern scientific thought and are therefore considered a credible part of the evolution of science.

However, Kircher's indexical signs do not imply a "modern" method of determining causality. In fact, many of Kircher's methods were not based on direct observations, but were instead secondhand accounts that he often accepted and elaborated upon. His use of others' testimony to support his holistic worldview can be seen in his descriptions of the sources of major rivers of the world. In Book 2, a synthesis of Kircher's understanding of the physical planet, he first describes the "Mountains of the Moon" (Montes Lunae) in central Africa as the source for the Nile (Fig. 9). His description is derived from ancient Greek accounts. Kircher cites directly from the journal of Pedro Páez, a contemporary Jesuit, who had visited Ethiopia in the early 1600s:

On the 21st of April, in the year 1618, being here, together with the king and his army, I ascended the place, and observed every thing with great attention. I discovered first two round fountains, each about four

palms in diameter... The two openings of these fountains have no issue in the plain on the top of the mountain, but flow from the root of it. The second fountain lies about a stone-cast west from the first: the inhabitants say that this whole mountain is full of water, and add, that the whole plain about the fountain is floating and unsteady, a certain mark that there is water concealed under it; for which reason, the water does not overflow at the fountain, but forces itself with great violence out at the foot of the mountain. (Bruce, 1813, p. 445)

From such descriptions, Kircher envisaged that the Montes Lunae contained large subterranean lakes that fed the Nile River. Kircher then proceeded to project this idea onto other major rivers of the world. The Andes as source for the Amazon (Fig. 10A), the Rhaetian Alps as source for the Padus (Fig. 10B), and the Himalayas as source for the Ganges (Fig. 10C). Each river is described as being sourced from lakes beneath the mountains. From a semiotic viewpoint, the extension of this conceptual model in effect changes the sign system. The initial relationship between the Nile and the Montes Lunae is one of causality, and the mountains are therefore indexical signs. However, when Kircher projects this concept into unobserved regions of the world, the mountains and rivers become an iconic sign. For these other river systems, an associated mountain chain is perceived as resembling or imitating the relationship between Montes Lunae and the Nile River (the icon).



Figure 9. Kircher's illustration of large subterranean lakes beneath Montes Lunae as the source for the Nile and other African rivers. Kircher's ideas are based on ancient Greek accounts and the seventeenth-century journal of Pedro Páez, S.J.



Figure 10. Maps from Book 2 of *Mundus Subterraneus* (1664) illustrating the extension of Kircher's subterranean lake concept to the Amazon River in South America (A), the Padus River in Europe (B), and the Ganges River in Asia (C).

CONCLUSION

Instead of being dismissed as an anomaly in the linear upward evolution of the earth sciences, Kircher should be viewed as a transitional figure between medieval thought systems and the growing empirical movement of the Scientific Revolution. His examination of the earth is based on Plato's philosophy that the world was created by God as a manifestation of his own perfection. Kircher uses symbolism, allegory, and metaphor in *Mundus Subterraneus* from both an indexical and iconic perspective. From a semiotic viewpoint, Kircher used indexical and iconic signs to combine rational and empirical techniques that sustained his holistic view of the cosmos. In the modern ideal formulation of scientific observation and inquiry, indexical signs are acceptable authoritative causal links between observation and interpretation, but for Kircher, iconic signs were also legitimate articles to collect and employ because they were signs of God's work. Iconic signs could be religious images or conceptual ideas that Kircher projected onto the workings of Earth. Kircher's primary concern was to analyze data within the framework of his holistic worldview.

Kircher's methods can also be viewed as a precursor to the Huttonian "Principle of Uniformity" and the use of analogy to understand the workings of Earth. It has been noted by others that the medical background of James Hutton encouraged him to realize notable insights into the workings of Earth by treating it as a living organism and emphasizing its dynamic qualities and processes (Eiseley, 1960, p. 24). Hutton states,

The earth like the body of an animal, is wasted at the same time that it is repaired. It has a state of growth and augmentation; it has another state, which is that of diminution and decay. This world is thus destroyed in one part, but it is renewed in another.

As introduced here, Kircher preceded Hutton in the use of biological and alchemic analogies toward the discussion of active earth processes. Kircher, however, expanded upon this analogy within a holistic hermetic and religious framework.

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