

Philosophy of Technology

*The Technological Condition:
An Anthology*

Second Edition

Edited by

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Mining the Earth's Womb

Carolyn Merchant

The domination of the earth through technology and the corresponding rise of the image of the world as *Machina ex Deo* were features of the Scientific Revolution of the sixteenth and seventeenth centuries. During this period, the two ideas of mechanism and the domination of nature came to be core concepts and controlling images of our modern world. An organically oriented mentality prevalent from ancient times to the Renaissance, in which the female principle played a significant positive role, was gradually undermined and replaced by a technological mindset that used female principles in an exploitative manner. As Western culture became increasingly mechanized during the 1600s, a female nurturing earth and virgin earth spirit were subdued by the machine.

The change in controlling imagery was directly related to changes in human attitudes and behavior toward the earth. Whereas the older nurturing earth image can be viewed as a cultural constraint restricting the types of socially and morally sanctioned human actions allowable with respect to the earth, the new images of mastery and domination functioned as cultural sanctions for the denudation of nature. Society needed these new images as it continued the processes of commercialism and industrialization, which depended on activities directly altering the earth – mining, drainage, de-forestation, and assarting (grubbing up stumps to clear fields). The new activities utilized new technologies – lift and force

pumps, cranes, windmills, geared wheels, flap valves, chains, pistons, treadmills, under- and overshot watermills, fulling mills, flywheels, bellows, excavators, bucket chains, rollers, geared and wheeled bridges, cranks, elaborate block and tackle systems, worm, spur, crown, and lantern gears, cams and eccentrics, ratchets, wrenches, presses, and screws in magnificent variation and combination.

These technological and commercial changes did not take place quickly; they developed gradually over the ancient and medieval eras, as did the accompanying environmental deterioration. Slowly, over many centuries, early Mediterranean and Greek civilization had mined and quarried the mountainsides, altered the forested landscape, and overgrazed the hills. Nevertheless, technologies were low level, people considered themselves parts of a finite cosmos, and animism and fertility cults that treated nature as sacred were numerous. Roman civilization was more pragmatic, secular, and commercial and its environmental impact more intense. Yet Roman writers such as Ovid, Seneca, Pliny, and the Stoic philosophers openly deplored mining as an abuse of their mother, the earth. With the disintegration of feudalism and the expansion of Europeans into new worlds and markets, commercial society began to have an accelerated impact on the natural environment. By the sixteenth and seventeenth centuries, the tension between technological development in the world of action and the controlling organic images in the world of the mind had become too great.

Carolyn Merchant, "Mining the Earth's Womb," from *Machina ex Dea: Feminist Perspectives on Technology*, ed. Joan Rothschild (Oxford: Pergamon Press, 1983), pp. 99–117. © Carolyn Merchant. Reprinted by kind permission of the author.

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The old structures were incompatible with the new activities.

Both the nurturing and domination metaphors had existed in philosophy, religion, and literature — the idea of dominion over the earth in Greek philosophy and Christian religion; that of the nurturing earth, in Greek and other pagan philosophies. But, as the economy became modernized and the Scientific Revolution proceeded, the dominion metaphor spread beyond the religious sphere and assumed ascendancy in the social and political spheres as well. These two competing images and their normative associations can be found in sixteenth-century literature, art, philosophy, and science.

The image of the earth as a living organism and — nurturing mother had served as a cultural constraint restricting the actions of human beings. One does not readily slay a mother, dig into her entrails for gold, or mutilate her body, although commercial mining would soon require that. As long as the earth was considered to be alive and sensitive, it could be considered a breach of human ethical behavior to carry out destructive acts against it. For most traditional cultures, minerals and metals ripened in the uterus of the Earth Mother, mines were compared to her vagina, and metallurgy was the human hastening of the birth of the living metal in the artificial womb of the furnace — an abortion of the metals' natural growth cycle before its time. Miners offered propitiation to the deities of the soil and subterranean world, performed ceremonial sacrifices, and observed strict cleanliness, sexual abstinence, and fasting before violating the sacredness of the living earth by sinking a mine. Smiths assumed an awesome responsibility in precipitating the metal's birth through smelting, fusing, and beating it with hammer and anvil; they were often accorded the status of shaman in tribal rituals and their tools were thought to hold special powers (Eliade 1962, pp. 53–70, 79–96).

The Renaissance image of the nurturing earth still carried with it subtle ethical controls and restraints. Such imagery found in a culture's literature can play a normative role within the culture. Controlling images operate as ethical restraints or as ethical sanctions — as subtle "oughts" or "ought-nots." Thus, as the descriptive metaphors and images of nature change, a behavioral restraint can be changed into a sanction. Such a change in the image and description of nature was occurring during the course of the Scientific Revolution.

It is important to recognize the normative import of descriptive statements about nature. Contemporary

philosophers of language have critically reassessed the earlier positivist distinction between the "is" of science and the "ought" of society, arguing that descriptions and norms are not opposed to one another by linguistic separation into separate "is" and "ought" statements, but are contained within each other. Descriptive statements about the world can presuppose the normative; they are then ethic-laden. A statement's normative function lies in the use itself as description. The norms may be tacit assumptions hidden within the descriptions in such a way as to act as invisible restraints or moral ought-nots. The writer or culture may not be conscious of the ethical import yet may act in accordance with its dictates. The hidden norms may become conscious or explicit when an alternative or contradiction presents itself. Because language contains a culture within itself, when language changes, a culture is also changing in important ways. By examining changes in descriptions of nature, we can then perceive something of the changes in cultural values. To be aware of the interconnectedness of descriptive and normative statements is to be able to evaluate changes in the latter by observing changes in the former (Cavell 1971, pp. 148, 165).

Not only did the image of nature as nurturing mother contain ethical implications but the organic framework itself, as a conceptual system, also carried with it an associated value system. Contemporary philosophers have argued that a given normative theory is linked with certain conceptual frameworks and not with others. The framework contains within itself certain dimensions of structural and normative variation, while denying others belonging to an alternative or rival framework (Taylor 1973).

We cannot accept a framework of explanation and yet reject its associated value judgments, because the connections to the values associated with the structure are not fortuitous. New commercial and technological innovations, however, can upset and undermine an established conceptual structure. New human and social needs can threaten associated normative constraints, thereby demanding new ones.

While the organic framework was for many centuries sufficiently integrative to override commercial development and technological innovation, the acceleration of such changes throughout Western Europe during the sixteenth and seventeenth centuries began to undermine the organic unity of the cosmos and society. Because the needs and purposes of society as a whole were changing with the commercial revolution, the values associated with the organic view of nature were no longer applicable;

hence, the plausibility of the conceptual framework itself was slowly, but continuously, being threatened.

The Geocosm: The Earth As a Nurturing Mother

Not only was nature in a generalized sense seen as female, but also the earth, or geocosm, was universally viewed as a nurturing mother – sensitive, alive, and responsive to human action. The changes in imagery and attitudes relating to the earth were of enormous significance as the mechanization of nature proceeded. The nurturing earth would lose its function as a normative restraint as it changed to a dead, inanimate, physical system.

The macrocosm theory likened the cosmos to the human body, soul, and spirit with male and female reproductive components. Similarly, the geocosm theory compared the earth to the living human body, with breath, blood, sweat, and elimination systems.

For the Stoics, who flourished in Athens during the third century B.C., after the death of Aristotle, and in Rome through the first century A.D., the world itself was an intelligent organism; God and matter were synonymous. Matter was dynamic, composed of two forces: expansion and condensation – the former directed outward, the latter inward. The tension between them was the inherent force generating all substances, properties, and living forms in the cosmos and the geocosm.

Zeno of Citium (ca. 304 B.C.) and M. Tullius Cicero (106–43 B.C.) held that the world reasons, has sensation, and generates living rational beings: “The world is a living and wise being, since it produces living and wise beings” (Cicero 1775, p. 96). Every part of the universe and the earth was created for the benefit and support of another part. The earth generated and gave stability to plants, plants supported animals, and animals in turn served human beings; conversely, human skill helped to preserve these organisms. The Universe itself was created for the sake of rational beings – gods and men – but God’s foresight insured the safety and preservation of all things. Humankind was given hands to transform the earth’s resources and dominion over them: timber was to be used for houses and ships, soil for crops, iron for plows, and gold and silver for ornaments. Each part and imperfection existed for the sake and ultimate perfection of the whole.

The living character of the world organism meant not only that the stars and planets were alive, but that the earth too was pervaded by a force giving life and motion to the

living beings on it. Lucius Seneca (4 B.C.–A.D. 65), a Roman Stoic, stated that the earth’s breath nourished both the growths on its surface and the heavenly bodies above by its daily exhalations:

How could she nourish all the different roots that sink into the soil in one place and another, had she not an abundant supply of the breath of life? ... all these [heavenly bodies] draw their nourishment from materials of earth ... and are sustained ... by nothing else than the breath of the earth. ... Now the earth would be unable to nourish so many bodies ... unless it were full of breath, which it exhales from every part of it day and night. (Seneca 1910, p. 244)

The earth’s springs were akin to the human blood system; its other various fluids were likened to the mucus, saliva, sweat, and other forms of lubrication in the human body, the earth being organized “... much after the plan of our bodies, in which there are both veins and arteries, the former blood vessels, the latter air vessels. ... So exactly alike is the resemblance to our bodies in nature’s formation of the earth, that our ancestors have spoken of veins (= springs) of water.” Just as the human body contained blood, marrow, mucus, saliva, tears, and lubricating fluids, so in the earth there were various fluids. Liquids that turned hard became metals, such as gold and silver, other fluids turned into stones, bitumens, and veins of sulfur. Like the human body, the earth gave forth sweat: “There is often a gathering of thin, scattered moisture like dew, which from many points flows into one spot. The dowers call it *sweat*, because a kind of drop is either squeezed out by the pressure of the ground or raised by the heat” (Seneca 1910, pp. 126–27).

Leonardo da Vinci (1452–1519) elaborated the Greek analogy between the waters of the earth and the ebb and flow of human blood through the veins and heart:

The water runs from the rivers to the sea and from the sea to the rivers, always making the same circuit. The water is thrust from the utmost depth of the sea to the high summits of the mountains, where, finding the veins cut, it precipitates itself and returns to the sea below, mounts once more by the branching veins and then falls back, thus going and coming between high and low, sometimes inside, sometimes outside. It acts like the blood of animals which is always moving, starting from the sea of the heart and mounting to the summit of the head. (Cornford 1937, p. 330)

The earth’s venous system was filled with metals and minerals. Its veins, veinlets, seams, and canals coursed through the entire earth, particularly in the mountains.

Its humors flowed from the veinlets into the larger veins. The earth, like the human, even had its own elimination system. The tendency for both to break wind caused earthquakes in the case of the former and another type of quake in the latter:

The material cause of earth quakes ... is no doubt great abundance of wind, or store of gross and dry vapors, and spirits, fast shut up, and as a man would say, imprisoned in the caves, and dungeons of the earth; which wind, or vapors, seeking to be set at liberty, and to get them home to their natural lodgings, in a great fume, violently rush out, and as it were, break prison, which forcible eruption, and strong breath, causeth an earthquake (Gabriel Harvey quoted in Kendrick 1974, p. 542, spelling modernized).

Its bowels were full of channels, fire chambers, glory holes, and fissures through which fire and heat were emitted, some in the form of fiery volcanic exhalations, others as hot water springs. The most commonly used analogy, however, was between the female's reproductive and nurturing capacity and the mother earth's ability to give birth to stones and metals within its womb through its marriage with the sun.

In his *De Rerum Natura* of 1565, the Italian philosopher Bernardino Telesio referred to the marriage of the two great male and female powers: "We can see that the sky and the earth are not merely large parts of the world universe, but are of primary – even principal rank. ... They are like mother and father to all the others" (Telesio 1967, p. 308). The earth and the sun served as mother and father to the whole of creation: all things are "made of earth by the sun and that in the constitution of all things the earth and the sun enter respectively as mother and father." According to Giordano Bruno (1548–1600), every human being was "a citizen and servant of the world, a child of Father Sun and Mother Earth" (Bruno 1964, p. 72).

A widely held alchemical belief was the growth of the baser metals into gold in womblike matrices in the earth. The appearance of silver in lead ores or gold in silvery assays was evidence that this transformation was underway. Just as the child grew in the warmth of the female womb, so the growth of metals was fostered through the agency of heat, some places within the earth's crust being hotter and therefore hastening the maturation process. "Given to gold, silver, and the other metals [was] the vegetative powers whereby they could also reproduce themselves. For, since it was impossible for God to make anything that was not perfect, he gave to all created things, with their being, the power of multiplication,"

The sun acting on the earth nurtured not only the plants and animals but also "the metals, the broken sulfuric, bituminous, or nitrogenous rocks; ... as well as the plants and animals – if these are not made of earth by the sun, one cannot imagine of what else or by what other agent they could be made" (Telesio 1967, p. 309).

The earth's womb was the matrix or mother not only of metals but also of living things. Paracelsus compared the earth to a female whose womb nurtured all life.

Woman is like the earth and all the elements and in this sense she may be considered a matrix; she is the tree which grows in the earth and the child is like the fruit born of the tree. ... Woman is the image of the tree. Just as the earth, its fruits, and the elements are created for the sake of the tree and in order to sustain it, so the members of woman, all her qualities, and her whole nature exist for the sake of her matrix, her womb. ...

And yet woman in her own way is also a field of the earth and not at all different from it. She replaces it, so to speak: she is the field and the garden mold in which the child is sown and planted (Paracelsus 1951, p. 25).

The earth in the Paracelsian philosophy was the mother or matrix giving birth to plants, animals, and men.

The image of the earth as a nurse, which had appeared in the ancient world in Plato's *Timaeus* and the *Emerald Tablet* of Hermes Trismegistus, was a popular Renaissance metaphor. According to sixteenth-century alchemist Basil Valentine, all things grew in the womb of the earth, which was alive, and vital, and the nurse of all life:

The quickening power of the earth produces all things that grow forth from it, and he who says that the earth has no life makes a statement flatly contradicted by facts. What is dead cannot produce life and growth, seeing that it is devoid of the quickening spirit. ... This spirit is the life and soul that dwell in the earth, and are nourished by heavenly and sidereal influences. ... This spirit is itself fed by the stars and is thereby rendered capable of imparting nutriment to all things that grow and of nursing them as a mother does her child while it is yet in the womb. ... If the earth were deserted by this spirit it would be dead (Valentine 1974, p. 333).

In general, the Renaissance view was that all things were permeated by life, there being no adequate method by which to designate the inanimate from the animate. It was difficult to differentiate between living and nonliving things because of the resemblance in structures. Like plants and animals, minerals and gems were filled with small pores, tubelets, cavities, and streaks through which

they seemed to nourish themselves. Crystalline salts were compared to plant forms, but criteria by which to differentiate the living from the nonliving could not successfully be formulated. This was due not only to the vitalistic framework of the period but to striking similarities between them. Minerals were thought to possess a lesser degree of the vegetative soul, because they had the capacity for medicinal action and often took the form of various parts of plants. By virtue of the vegetative soul, minerals and stones grew in the human body, in animal bodies, within trees, in the air and water, and on the earth's surface in the open country (Adams 1938, pp. 102-36).

Popular Renaissance literature was filled with hundreds of images associating nature, matter, and the earth with the female sex. The earth was alive and considered to be a beneficent, receptive, nurturing female. For most writers, there was a mingling of traditions based on ancient sources. In general, the pervasive animism of nature created a relationship of immediacy with the human being.

An I-thou relationship in which nature was considered to be a person-writ-large was sufficiently prevalent that the ancient tendency to treat it as another human still existed. Such vitalistic imagery was thus so widely accepted by the Renaissance mind that it could effectively function as a restraining ethic.

In much the same way, the cultural belief-systems of many American Indian tribes had for centuries subtly guided group behavior toward nature. Smohalla of the Columbia Basin Tribes voiced the Indian objections to European attitudes in the mid-1800s:

You ask me to plow the ground! Shall I take a knife and tear my mother's breast? Then when I die she will not take me to her bosom to rest.

You ask me to dig for stone! Shall I dig under her skin for her bones? Then when I die I cannot enter her body to be born again.

You ask me to cut grass and make hay and sell it, and be rich like white men! But how dare I cut off my mother's hair? (quoted in McLuhan 1971, p. 56).

In the 1960s, the Native American became a symbol in the ecology movement's search for alternatives to Western exploitative attitudes. The Indian animistic belief-system and reverence for the earth as a mother were contrasted with the Judeo-Christian heritage of dominion over nature and with capitalist practices resulting in the "tragedy of the commons" (exploitation of resources available for any person's or nation's use). But

as will be seen, European culture was more complex and varied than this judgment allows. It ignores the Renaissance philosophy of the nurturing earth as well as those philosophies and social movements resistant to mainstream economic change.

Normative Constraints against the Mining of Mother Earth

If sixteenth-century descriptive statements and imagery can function as an ethical constraint and if the earth was widely viewed as a nurturing mother, did such imagery actually function as a norm against improper use of the earth? Evidence that this was indeed the case can be drawn from theories of the origins of metals and the debates about mining prevalent during the sixteenth century.

What ethical ideas were held by ancient and early modern writers on the extraction of the metals from the bowels of the living earth? The Roman compiler Pliny (A.D. 23-79), in his *Natural History*, had specifically warned against mining the depth of Mother Earth, speculating that earthquakes were an expression of her indignation at being violated in this manner:

We trace out all the veins of the earth, and yet ... are astonished that it should occasionally cleave asunder or tremble: as though, forsooth, these signs could be any other than expressions of the indignation felt by our sacred parent! We penetrate into her entrails, and seek for treasures ... as though each spot we tread upon were not sufficiently bounteous and fertile for us! (Pliny 1858, vol. 6, pp. 68-69)

He went on to argue that the earth had concealed from view that which she did not wish to be disturbed, that her resources might not be exhausted by human avarice:

For it is upon her surface, in fact, that she has presented us with these substances, equally with the cereals, bounteous and ever ready, as she is, in supplying us with all things for our benefit! It is what is concealed from our view, what is sunk far beneath her surface, objects, in fact, of no rapid formation, that urge us to our ruin, that send us to the very depth of hell ... when will be the end of thus exhausting the earth, and to what point will avarice finally penetrate! (Pliny 1858, vol. 6, p. 69)

Here, then, is a striking example of the restraining force of the beneficent mother image — the living earth in her wisdom has ordained against the mining of metals by concealing them in the depths of her womb.

While mining gold led to avarice, extracting iron was the source of human cruelty in the form of war, murder, and robbery. Its use should be limited to agriculture and those activities that contributed to the "honors of more civilized life":

For by the aid of iron we lay open the ground, we plant trees, we prepare our vineyard trees, and we force our vines each year to resume their youthful state, by cutting away their decayed branches. It is by the aid of iron that we construct houses, cleave rocks, and perform so many other useful offices of life. But it is with iron also that wars, murders, and robberies are effected, ... not only hand to hand, but ... by the aid of missiles and winged weapons, now launched from engines, now hurled by the human arm, and now furnished with feathery wings. Let us therefore acquit nature of a charge that here belongs to man himself (Pliny 1858, vol. 6, p. 205).

In past history, Pliny stated, there had been instances in which laws were passed to prohibit the retention of weapons and to ensure that iron was used solely for innocent purposes, such as the cultivation of fields.

In the *Metamorphoses* (A.D. 7), the Roman poet Ovid wrote of the violence done to the earth during the age of iron, when evil was let loose in the form of trickery, slyness, plotting, swindling, and violence, as men dug into the earth's entrails for iron and gold:

The rich earth
Was asked for more; they dug into her vitals.
Pried out the wealth a kinder lord had hidden
In stygian shadow, all that precious metal,
The root of evil. They found the guilt of iron.
And gold, more guilty still. And War came forth.
(Ovid 1955, I. 137-43)

The violation of Mother Earth resulted in new forms of monsters, born of the blood of her slaughter:

Jove struck them down
With thunderbolts, and the bulk of those huge bodies
Lay on the earth, and bled, and Mother earth,
Made pregnant by that blood, brought forth new bodies,
And gave them, to recall her older offspring,
The forms of men. And this new stock was also
Contemtuously of gods, and murder-hungry
And violent. You would know they were sons of blood.
(Ovid 1955, I. 155-62)

Seneca also deplored the activity of mining, although, unlike Pliny and Ovid, he did not consider it a new vice, but one that had been handed down from ancient times.

"What necessity caused man, whose head points to the stars, to stoop, below, burying him in mines and plunging him in the very bowels of innermost earth to root up gold?" Not only did mining remove the earth's treasures, but it created "a sight to make [the] hair stand on end - huge risers and vast reservoirs of sluggish waters." The defiling of the earth's waters was even then a noteworthy consequence of the quest for metals (Seneca 1910, p. 207-08).

These ancient strictures against mining were still operative during the early years of the commercial revolution when mining activities, which had lapsed after the fall of Rome, were once again revived. Ultimately, such constraints would have to be defeated by proponents of the new mercantilist philosophy.

An allegorical tale, reputedly sent to Paul Schneevogel, a professor at Leipzig about 1490-1495, expressed opposition to mining encroachments into the farmlands of Lichtenstat in Saxony, Germany, an area where the new mining activities were developing rapidly. In the following allegorical vision of an old hermit of Lichtenstat, Mother Earth is dressed in a tattered green robe and seated on the right hand of Jupiter who is represented in a court case by "glib-tongued Mercury" who charges a miner with matricide. Testimony is presented by several of nature's deities:

Bacchus complained that his vines were uprooted and fed to the flames and his most sacred places desecrated. Ceres stated that her fields were devastated; Pluto that the blows of the miners resound like thunder through the depths of the earth, so that he could hardly reside in his own kingdom, the Naiad, that the subterranean waters were diverted and her fountains dried up; Charon that the volume of the underground waters had been so diminished that he was unable to float his boat on Acheron and carry the souls across to Pluto's realm, and the Fauns protested that the charcoal burners had destroyed whole forests to obtain fuel to smelt the miner's ores (Adams 1938, p. 172).

In his defense, the miner argued that the earth was not a real mother, but a wicked stepmother who hides and conceals the metals in her inner parts instead of making them available for human use.

In the old hermit's tale, we have a fascinating example of the relationship between images and values. The older view of nature as a kindly mother is challenged by the growing interests of the mining industry in Saxony, Bohemia, and the Harz Mountains, regions of newly found prosperity. The miner, representing these newer

commercial activities, transforms the image of the nurturing mother into that of a stepmother who wickedly conceals her bounty from the deserving and needy children.

Henry Cornelius Agrippa's polemic *The Vanity of Arts and Sciences* (1530) reiterated some of the moral strictures against mining found in the ancient treatises, quoting the passage from Ovid portraying miners digging into the bowels of the earth in order to extract gold and iron. "These men," he declared, "have made the very ground more hurtful and pestiferous, by how much they are more rash and venturous than they that hazard themselves in the deep to dive for pearls." Mining thus despoiled the earth's surface, infecting it, as it were, with an epidemic disease (Agrippa 1694, pp. 81-82).

If mining were to be freed of such strictures and sanctioned as a commercial activity, the ancient arguments would have to be refuted. This task was taken up by Georg Agricola (1494-1555), who wrote the first "modern" treatise on mining. His *De Re Metallica* ("On Metals," 1556) marshaled the arguments of the detractors of mining in order to refute them and thereby promote the activity itself.

According to Agricola, people who argued against the mining of the earth for metals did so on the basis that nature herself did not wish to be discovered what she herself had concealed:

The earth does not conceal and remove from our eyes those things which are useful and necessary to mankind, but, on the contrary, like a beneficent and kindly mother she yields in large abundance from her bounty and brings into the light of day the herbs, vegetables, grains, and fruits, and trees. The minerals, on the other hand, she buries far beneath in the depth of the ground, therefore they should not be sought (Agricola 1950, pp. 6-7).

This argument, taken directly from Pliny, reveals the normative force of the image of the earth as a nurturing mother.

A second argument of the detractors, reminiscent of Seneca and Agrippa, and based on Renaissance "ecological" concerns was the disruption of the natural environment and the pollutive effects of mining.

But, besides this, the strongest argument of the detractors [of mining] is that the fields are devastated by mining operations, for which reason formerly Italians were warned by law that no one should dig the earth for metals and so injure their very fertile fields, their vineyards, and

their olive groves. Also they argue that the woods and groves are cut down, for there is need of wood for timbers, machines, and the smelting of metals. And when the woods and groves are felled, then are exterminated the beasts and birds, many of which furnish a pleasant and agreeable food for man. Further, when the ores are washed, the water which has been used poisons the brooks and streams, and either destroys the fish or drives them away. Therefore the inhabitants of these regions, on account of the devastation of their fields, woods, groves, brooks, and rivers, find great difficulty in procuring the necessities of life, and by reason of the destruction of the timber they are forced to greater expense in erecting buildings. Thus it is said, it is clear to all that there is greater detriment from mining than the value of the metals which the mining produces (Agricola 1950, p. 8).

Agricola may have been alluding to laws passed by the Florentines between 1420 and 1485, preventing people from dumping lime into rivers upstream from the city for the purpose of "poisoning or catching fish," as it caused severe problems for those living downstream. The laws were enacted both to preserve the trout, "a truly noble and impressive fish" and to provide Florence with "a copious and abundant supply of such fish" (Trexler 1974, p. 463).

Such ecological consciousness, however, suffered because of the failure of law enforcement, as well as because of the continuing progress of mining activities. Agricola, in his response to the detractors of mining, pointed out the congruences in the need to catch fish and to construct metal tools for the well-being of the human race. His effort can be interpreted as an attempt to liberate the activity of mining from the constraints imposed by the organic framework and the nurturing earth image, so that new values could sanction and hasten its development.

To the argument that the woods were cut down and the price of timber therefore raised, Agricola responded that most mines occurred in unproductive, gloomy areas. Where the trees were removed from more productive sites, fertile fields could be created, the profits from which would reimburse the local inhabitants for their losses in timber supplies. Where the birds and animals had been destroyed by mining operations, the profits could be used to purchase "birds without number" and "edible beasts and fish elsewhere" and refurbish the area (Agricola 1950, p. 17).

The vices associated with the metals — anger, cruelty, discord, passion for power, avarice, and lust — should be

attributed instead to human conduct: "It is not the metals which are to be blamed, but the evil passions of men which become inflamed and ignited; or it is due to the blind and impious desires of their minds." Agricola's arguments are a conscious attempt to separate the older normative constraints from the image of the metals themselves so that new values can then surround them (Agricola 1950, p. 16).

Edmund Spenser's treatment of Mother Earth in the *Faerie Queene* (1595) was representative of the concurrent conflict of attitudes about mining the earth. Spenser entered fully into the sixteenth-century debates about the wisdom of mining, the two greatest sins against the earth being, according to him, avarice and lust. The arguments associating mining with avarice had appeared in the ancient texts of Pliny, Ovid, and Seneca, while during Spenser's lifetime the sermons of Johannes Mathesius, entitled *Bereggpostilla, oder Sarepta* (1578), inveighed against the moral consequences of human greed for the wealth created by mining for metals (Kendrick 1974, pp. 548-53).

In Spenser's poem, Guyon presents the arguments against mining taken from Ovid and Agricola, while the description of Mammon's forge is drawn from the illustrations to the *De Re Metallica*. Gold and silver pollute the spirit and debase human values just as the mining operation itself pollutes the "purest streams" of the earth's womb:

Then gan a cursed hand the quiet wombe
Of his great Grandmother with steele to wound,
And the hid treasures in her sacred tombe
With Sacrilege to dig. Therein he found
Fountaines of gold and silver to abound,
Of which the matter of his huge desire
And pompous pride eftsoones he did compound.
(Spenser 1758, Bk II, Canto 7, verse 17)

The earth in Spenser's poem is passive and docile, allowing all manner of assault, violence, ill-treatment, rape by lust, and despoilment by greed. No longer a nurturer, she indiscriminately, as in Ovid's verse, supplies flesh to all life and lacking in judgment brings forth monsters and evil creatures. Her offspring fall and bite her in their own death throes. The new mining activities have altered the earth from a bountiful mother to a passive receptor of human rape (Kendrick 1974).

John Milton's *Paradise Lost* (1667) continues the Ovidian image, as Mammon leads "bands of pioneers with Spade and Pickaxe" in the wounding of the living female earth:

...By him first
Men also, and by his suggestion taught.
Ransack'd the Center, and with impious hands
Rifl'd the bowels of their mother Earth
For Treasures better hid. Soon had his crew
Op'nd into the Hill a spacious wound
And dig'd out ribs of Gold.

(Milton 1975, Bk I, 11. 684-90)

Not only did mining encourage the mortal sin of avarice, it was compared by Spenser to the second great sin, human lust. Digging into the matrices and pockets of earth for metals was like mining the female flesh for pleasure. The sixteenth- and seventeenth-century imagination perceived a direct correlation between mining and digging into the nooks and crannies of a woman's body. Both mining and sex represent for Spenser the return to animality and earthly slime. In the *Faerie Queene*, lust is the basest of all human sins. The spilling of human blood, in the rush to rape the earth of her gold, taints and muddies the once fertile fields (Kendrick 1974).

The sonnets of the poet and divine John Donne (1573-1631) also played up the popular identity of mining with human lust. The poem "Love's Alchemie" begins with the sexual image, "Some that have deeper digged loves Myne than I, say where his centrique happiness doth lie" (Donne 1957, p. 35). The Platonic lover, searching for the ideal or "centrique" experience of love, begins by digging for it within the female flesh, an act as debasing to the human being as the mining of metals is to the female earth. Happiness is not to be obtained by avarice for gold and silver, nor can the alchemical elixir be produced from base metals. Nor does ideal love result from an ascent up the hierarchical ladder from base sexual love to the love of poetry, music, and art to the highest Platonic love of the good, virtue, and God. The same equation appears in Elegie XVIII, "Love's Progress":

Search every sphaere
And firmament, our Cupid is not there;
He's an infernal god and under ground,
With Pluto dwells, where gold and fire abound:
Men to such Gods, their sacrificing Coles,
Did not in Altars lay, but pits and holes,
Although we see Celestial bodies move
Above the earth, the earth we Till and love:
So we her ayres contemplate, words and heart
And Virtues; but we love the Centrique part.

(Donne 1957, p. 104, 11. 27-36)

Lust and love of the body do not lead to the celestial love of higher ideals; rather, physical love is associated with the pits and holes of the female body, just as the love of gold depends on the mining of Pluto's caverns within the female earth, "the earth we till and love." Love of the sexual "centrique" part of the female will not lead to the airy spiritual love of virtue. The fatal association of monetary revenue with human avarice, lust, and the female mine is driven home again in the last lines of the poem:

Rich Nature hath in women wisely made
Two purses, and their mouths aversely laid:
They then, which to the lower tribute owe,
That way which that Exchequer looks, must go.

Avarice and greed after money corrupted the soul, just as lust after female flesh corrupted the body.

The comparison of the female mine with the new American sources of gold, silver, and precious metals appears again in *Elegie XIX*, "Going to Bed." Here, however, Donne turns the image upside down and uses it to extoll the virtues of the mistress.

License my roaving hands, and let them go,
Before, behind, between, above, below.
O my America! my new-found-land,
My kingdome, safeliest when with one man man'd
My Myne of precious stones, My Emperie,
How blest am I in this discovering thee!

(Donne 1957, p. 107, ll. 25-30)

In these lines, the comparison functions as a sanction — the search for precious gems and metals, like the sexual exploration of nature or the female, can benefit a kingdom or a man.

Moral restraints were thus clearly affiliated with the Renaissance image of the female earth and were strengthened by associations with greed, avarice, and lust. But the analogies were double-edged. If the new values connected with mining were positive, and mining was viewed as a means to improve the human condition, as they were by Agricola, then the comparison could be turned upside down. Sanctioning mining sanctioned the rape or technological exploration of the earth. The organic framework, in which the Mother-Earth image was a moral restraint against mining, was literally being undermined by the new commercial activity.

In the seventeenth century, Francis Bacon carried the new ethic a step further through metaphors that compared miners and smiths to scientists and technologists

penetrating nature and shaping her on the anvil. Bacon's new man of science must not think that the "inquisition of nature is in any part interdicted or forbidden." Nature must be "bound into service" and made a "slave," put "in constraint" and "molded" by the mechanical arts. The "searchers and spies of nature" are to discover her plots and secrets (Bacon 1870, vol. 4, pp. 20, 287, 294).

This method, so readily applicable when nature is denoted by the female gender, degraded and made possible the exploitation of the natural environment. Nature's womb harbored secrets that through technology could be wrested from her grasp for use in the improvement of the human condition:

There is therefore much ground for hoping that there are still laid up in the womb of nature many secrets of excellent use having no affinity or parallelism with anything that is now known ... only by the method which we are now treating can they be speedily and suddenly and simultaneously presented and anticipated (quoted in Marsak 1964, p. 45).

The final step was to recover and sanction man's dominion over nature. Due to the Fall from the Garden of Eden (caused by the temptation of a woman), the human race lost its "dominion over creation." Before the Fall, there was no need for power or dominion, because Adam and Eve had been made sovereign over all other creatures. In this state of dominion, mankind was "like unto God." While some, accepting God's punishment, had obeyed the medieval strictures against searching too deeply into God's secrets, Bacon turned the constraints into sanctions. Only by "digging further and further into the mine of natural knowledge" could mankind recover that lost dominion. In this way, "the narrow limits of man's dominion over the universe" could be stretched "to their promised bounds" (Bacon 1870, vol. 4, p. 247, vol. 3, pp. 217, 219; Bacon 1964, p. 62).

Although a female's inquisitiveness may have caused man's fall from his god-given dominion, the relentless interrogation of another female, nature, could be used to regain it. As he argued in *The Masculine Birth of Time*, "I am come in very truth leading to you nature with all her children to bind her to your service and make her your slave." "We have no right," he asserted, "to expect nature to come to us." Instead, "Nature must be taken by the forelock, being bald behind." Delay and subtle argument "permit one only to clutch at nature, never to lay hold of her and capture her" (Bacon 1964, pp. 62, 129, 130).

Nature existed in three states – at liberty, in error, or in bondage:

She is either free and follows her ordinary course of development as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and forwardness of matter and violence of impediments, as in the case of monsters; or lastly, she is put in constraint, molded, and made as it were new by art and the hand of man; as in things artificial (Bacon 1870, vol. 4, p. 294).

The first instance was the view of nature as immanent self-development, the nature naturing herself of the Aristotelians. This was the organic view of nature as a living, growing, self-actualizing being. The second state was necessary to explain the malfunctions and monstrosities that frequently appeared and that could not have been caused by God or another higher power acting on his instruction. Since monstrosities could not be explained by the action of form or spirit, they had to be the result of matter acting perversely. Matter in Plato's *Timaeus* was recalcitrant and had to be forcefully shaped by the demiurge. Bacon frequently described matter in female imagery, as a "common harlot." "Matter is not devoid of an appetite and inclination to dissolve the world and fall back into the old chaos." It therefore must be "restrained and kept in order by the prevailing concord of things." "The vexations of art are certainly as the bonds and handcuffs of Proteus, which betray the ultimate struggles and efforts of matter" (Bacon 1870, vol. 4, pp. 320, 325, 257).

The third instance was the case of art (techne) – man operating on nature to create something new and artificial. Here, "nature takes orders from man and works under his authority." Miners and smiths should become the model for the new class of natural philosophers who would interrogate and alter nature. They had developed the two most important methods of wresting nature's secrets from her, "the one searching into the bowels of nature, the other shaping nature as on an anvil." "Why should we not divide natural philosophy into two parts, the mine and the furnace?" For "the truth of nature lies hid in certain deep mines and caves," within the earth's bosom. Bacon, like some of the practically minded alchemists, would "advise the studios to sell their books and build furnaces" and, "forsaking Minerva and the Muses as barren virgins, to rely upon Vulcan" (Bacon 1870, vol. 4, pp. 343, 287, 343, 393).

The new method of interrogation was not through abstract notions, but through the instruction of the understanding "that it may in very truth dissect nature." The instruments of the mind supply suggestions, those of the hand give motion and aid the work. "By art and the hand of man," nature can then be "forced out of her natural state and squeezed and molded." In this way, "human knowledge and human power meet as one" (Bacon 1870, vol. 4, pp. 246, 29, 247).

Here, in bold sexual imagery, is the key feature of the modern experimental method – constraint of nature in the laboratory, dissection by hand and mind, and the penetration of hidden secrets – language still used today in praising a scientist's "hard facts," "penetrating mind," or the "thrust of his argument." The constraints against mining the earth have been turned into sanctions in language that legitimates the exploitation and "rape" of nature for human good.

Scientific method, combined with mechanical technology, would create a "new organon," a new system of investigation, that unified knowledge with material power. The technological discoveries of printing, gunpowder, and the magnet in the fields of learning, warfare, and navigation "help us to think about the secrets still locked in nature's bosom." "They do not, like the old, merely exert a gentle guidance over nature's course; they have the power to conquer and subdue her, to shake her to her foundations." Under the mechanical arts, "nature betrays her secrets more fully ... than when in enjoyment of her natural liberty" (Bacon 1964, pp. 96, 93, 99).

Mechanics, which gave man power over nature, consisted in motion; that is, in "the uniting or disuniting of natural bodies." Most useful were the arts that altered the materials of things – "agriculture, cookery, chemistry, dying, the manufacture of glass, enamel, sugar, gunpowder, artificial fires, paper, and the like." But in performing these operations, one was constrained to operate within the chain of causal connections; nature could "not be commanded except by being obeyed." Only by the study, interpretation, and observation of nature could these possibilities be uncovered; only by acting as the interpreter of nature could knowledge be turned into power. Of the three grades of human ambition, the most wholesome and noble was "to endeavor to establish and extend the power and dominion of the human race itself over the universe." In this way, "the human race [could] recover that right over nature which belongs to it by divine bequest" (Bacon 1870, Vol. 4, pp. 294, 257, 32, 114, 115).

By the close of the seventeenth century, a new science of mechanics in combination with the Baconian ideal of technological mastery over Nature had helped to create the modern worldview. The core of female principles

that had for centuries subtly guided human behavior toward the earth had given way to a new ethic of exploitation. The nurturing earth mother was subdued by science and technology.

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