SWEDENBORG AND HIS SCIENTIFIC REVIEWERS[*†]

In the second volume *On Iron*, the first Class treats of:[111] The mode of smelting iron ore generally used in Sweden (p. 1). The furnaces and iron works in Sweden. (p. 62). Native silver found in an iron mine (p. 67): The re-roasting of iron in Swedish iron works (p: 72). The smelting of bog- and lake-ore in Sweden (p. 105). The Swedish iron *Osmund*[112] (p. 119). The mode of smelting used in Roslag, Sweden (p. 115). The re-roasting of iron in the iron-hearths at Roslag (p. 133). The mode of smelting and re-roasting iron in France (p. 142), Liège (p. 148), Italy (p. 149), and around Lesso and Pelagio (p. 153), in England (p. 154), Maryland in India[113] (p. 162), Russia and Siberia (p. 164), Norway (p. 168), Silesia (p. 170), Saxony (p. 171), Hercynia (p. 175), Fordenberg, Styria and Carinthia (p. 177); the unusual mode used at Saltzberg (p. 184); the mode according to Agricola (p. 188). An experiment with wood and combustible earth (p. 190). The hardening of iron used by the Indians[114] (p. 194). The mode of converting crude iron directly into steel as used in several places in Sweden (p. 195), France (p. 208), Saltzburg (p. 210), Carinthia, Tirolia and Stiria (p. 211); according to Agricola (p. 213). The art of softening iron according to M. Reaumur (p. 215); and of casting it into forms (p. 218). Experiments with material of different kinds used for softening iron (p. 225), with the cautions to be observed (p. 231). The extinctions of iron (p. 239). The smelting of iron by means of menstrua (p. 247). The mode of whitening iron or of

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[*] Continued from this journal vol. CVII (Jan.–June 2004): 85. Reprinted from *The New Philosophy* XXXII (Jan.–Oct. 1929, nos. 1–4): 140–160.

[†] The reprinting of "Swedenborg and His Scientific Reviewers" began in *The New Philosophy* CVI (Jan.–June 2003, nos. 1 & 2), and has continued through the present issue with a break in 2005. The material has been published in its original order except for the section published in *The New Philosophy* CVII (July–Dec. 2004, nos. 3 & 4): 129–159, which actually comes after the material in this issue. Some of the 2003 and 2004 footnotes identifiying the sources of the reprinted material were not correct. The correct identifications are as follows: *The New Philosophy* CVI (Jan.–June 2003, nos. 1 & 2): 449–498, reprinted from *The New Philosophy* XXXII (Jan.–Oct. 1929, nos. 1–4): 19–68; *The New Philosophy* CVI (July–Dec. 2003, nos. 3 & 4): 535–574, reprinted from *The New Philosophy* XXXII (Jan.–Oct. 1929, nos. 1–4): 68–109; *The New Philosophy* CVII (Jan.–June 2004, nos. 1 & 2): 53–85, reprinted from *The New Philosophy* XXXII (Jan.–Oct. 1929, nos. 1–4): 109–140; *The New Philosophy* CVII (July–Dec. 2004, nos. 3 & 4): 129–159, reprinted from *The New Philosophy* XXXIII (Jan. 1930): 161–192.

making it like silver (p. 248). On rusting (p. 249); preservation from rust (p. 250). The mode used in various places for cutting iron into bars (p. 252).

Class II treats of the proving of iron ore by the magnet (p. 257); its proving in a crucible (p. 260); its proving for gold and silver (p. 263); the modes of exploring the quality of crude and wrought iron (p. 265). Signs gathered from the fracture of iron, extracted from M. Reaumur (p. 276). A comparison of steel and iron (p. 278). Different kinds of iron ore in various places (p. 284). Iron in earth and mud, plants and living creatures (p. 292). The stones hematite and schist (p. 295).

Class III. Iron filings (p. 301). The aperient crocus of Mars (p. 303); the astringent crocus of Mars (p. 305); the same for the use of glassmakers (p. 307). The preparation of the color red, in Sweden and elsewhere (p. 309). Crocus of Mars prepared with antimony. (p. 316). The aperient tincture of Mars, and Mars diaphoreticus (pp. 312, 316[115]); the tincture of Mars (p. 323) the astringent of Mars (p. 324). Water having a sour taste (p. 326). The flowers of Mars (p. 329); the oil of Mars (p. 330). Salt and vitriol from iron (p. 331). Various things from hematite (p. 336). The specific weight of iron (p. 340). Solutions of iron in acids (p. 342). Effervescences and chemical changes with iron, its vitriol and oil of vitriol (p. 345). Collected experiments with iron (p. 360). The particles and elements of iron and its vitriol in fountains and divers acid springs, with chemical experiments instituted with such waters (p. 366).

The third volume, *On Copper*.

In the first Class, the author deals with the smelting process for copper as used in Fahlun (p. 1); attempts at improving this process (p. 42). The precipitation of copper, with examples of its precipitation by iron (p. 49). The smelting method used in other parts of Sweden (pp. 66–110), in Norway (p. 115), Russia (p. 133), England (p. 135); around the Pyrenaean Mountains (p. 141); at Agort (p. 144), Pubel and Innsbruck (p. 146); in Hungary (p. 149); at Guttenberg in Bohemia (p. 159); in Eisleben and Mansfeld (p. 168); in Saxony (p. 175); at Saugerhausen (p. 177); in Berga, Wickerod, Iljenau and Altenau (p. 182); at Gralslitz (p. 184); in Franckenberg (p. 186), Andreasberg (p. 187), Goslar (p. 191), Hercynia (p. 197), Sauterberg (p. 200), Stotberg, Strasberg, Dresburg (p. 204). The purification of copper in Germany (p. 205). Copper in India, quoted from Alfonso Barba (p. 207).

On copper, quoted from Agricola (p. 208), Roessler and Loehneis (p. 219). A mode of crude smelting (p. 226). Experiments in copper smelting according to Kellner (p. 234). Experiments in copper smelting, extracted from the tract *Vom Ertzbeitzen* (p. 239). The separation of schist from copper in Hungary (p. 247), Guttenberg (p. 268), Haecksten (p. 272), Gunthal (p. 278), Hercynia (p. 282), Andreasberg (p 283), Goslar (p. 286); from other authors (p. 288). On bronze and its preparation; and first, on the calamine stone of Aix-la-Chapelle, England, Goslar, Saxony, and elsewhere (p. 341). The preparation of bronze in Sweden (p. 347), England (p. 353), Germany (p. 355 *seq.).* Bell-metal (p. 361). A metal of the color of gold (p. 378). Zinc (p. 382). White metal (p. 385). Modes of silvering copper or painting it with a silver color (p. 395).

Class II treats of divers kinds of copper ore (p. 404). Provings of copper ore (p. 416); the proving of copper ore for silver (p. 434), etc.

Class III treats of the preparation of rust or verdigris (p. 449). The process and various modes of preparing ultramarine or cerulean (p. 463). Burnt brass (p. 488), etc. (*Deutsche Act. Erud.*, n. 186 [Oct.], 1734, pp. 407–20).

> Note. The frontispiece of this number of the *Deutsche Acta Eruditorum* is a portrait of Swedenborg reproduced from the first volume of the *Opera Philosophica.*

Neue Zeitungen von Gelehrten Sachen

The above reviews were noted in the *Neue Zeitungen* for July 12 (p. 495) and October 25 (p. 76), 1734.

Commercium Litterarium[116]

New Books: Emanuel Swedenborg, Assessor of the Royal College of Mines of the kingdom of Sweden, *Philosophical and Mineralogical Works*, 3 volumes.

The *first* volume had on the title-page: Emanuel Swedenborg, The Principles of Natural Things, or of new attempts to explain the Phenomena of the elementary world philosophically; with copperplates. Dresden and Leipzig, at the expense of Fred. Hekel, Royal Bookseller, 1734, fol. 4 alphabets, 20 sheets. Title, Dedication and Preface, 4 sheets. Plates 28.

The *second:* The Subterraneum or Mineral Kingdom. On Iron and the methods of smelting it used in various places throughout Europe; the conversion of crude iron into steel; iron ore and its proving; likewise, chemical preparations and experiments made with iron and its vitriol, etc., etc.; with copperplates. Ibid. Same publisher and year. 4 alphabets, with 1/2 sheet title; dedication and preface, 3 sheets. 28 copperplates.

The *third:* The Subterranean or Mineral Kingdom. On Copper and brass; the modes of smelting copper used in various places throughout Europe; the separation of copper from silver; its conversion into bronze; and into metals of various kinds; the calamine stone; zinc; copper ore and its proving; likewise, on Chemical preparations and experiments made with copper, etc., etc.; with copperplates. Ibid. Published by the same, in the same year and form. 5 alphabets, 18 sheets. Title, Dedication and Preface 3 sheets. 90 copperplates (*Com. Lit.,* July 21, 1734, p. 232).

> Note. In the *Commentarium Literarium* for July 15th of the preceding year (1733), Swedenborg's name had been published in a list of the members of the Royal Swedish Academy of Sciences.

James Theobald[117]

In his first chapter the author treats of the steps necessary to the attainment of true philosophy, and what a true philosopher is. The means of attaining that character are three, namely: Experience, skill in geometry, and a faculty of reasoning.

By philosophy we learn the world's mechanism, and the three kingdoms of geometry, viz., the mineral, vegetable, and animal, and, if it may be admitted, Elementary powers. Under geometric powers and the laws of mechanism, all minerals and vegetables are routed; but the animal parts, as far as the anatomical and organic parts, under the vegetable.

Philosophy must assist us in the search of the occult qualities of things which our outward senses cannot convey to us, assisted by experience and geometry, and is the work of ages.

He treats of the extent of the power of the soul, and the method by which knowledge is conveyed, viz., by experience and time; and concludes that all wisdom centers in memory; that the end of all philosophy is to lead us to the knowledge of the Deity; that there are none but smatterers

in philosophy, who assert the world to be without a maker; or exclude the infinite Being from the formation of all things, or who confound Nature and Infinity; and that the greater degrees of wisdom men attain to, the higher veneration they will have for the Divine Being.

Chapter 2 is a philosophical inquiry into the first origin of things, or a search if its existence be infinite; which he endeavors to prove finite, by abundance of logical solutions.

Chapter 3 is a philosophical inquiry into the first or simple finite particles of matter, and [their origin] from a Point.

Chapter 4 is a philosophical inquiry into other finite beings, and how their origin, from being simple or one, is extended to such a number of beings; and, in general, of their coexistence, or the origin of their motion; and how they derived their being, geometrically from the same origin, or first simple finite.

Chapter 5 treats more especially of the action of the first finite beings; their origin from first simple finite beings; their motion, shape, state, and as well their other attributes as modifications; what this one active being is, which our sun is the cause of, as well as what the elements are; if action can be communicated to a point; and if it can, what it is.

6. Treats of the first universal element of the world, or of the first particles of the element composed of finite and active beings; of their motion, figure, attributes, and modes; as also of their origin and composition; of second finite and first active beings, and that this element constitutes vortexes, solar, and starry bodies; to which he adds a philosophical treatise of the geometrical figure of the earth, and a mechanical treatise of its situation, the motion of its parts, its composition as well in its finite parts as its active and elementary ones; all which he endeavors to illustrate by several mathematical figures.

7. Treats of the second and third degrees of motion.

8. Treats of the finite or third degree.

9. Treats of the elements of another world, or magnetical elements; the particles of the other elements, composed of third finite parts, second active, and first composite parts, their motion, figure, attributes and mode; and to prove that this element, as well as the former, constitutes a solar vortex, and contributes in an especial manner to the phenomena which appear about a magnet.

10. Treats of the existence of the sun, and of the formation of a solar vortex.

PART THE SECOND

Chapter 1 treats of the causes and mechanism of the magnetic powers.

2. Treats of the attractive forces of two or more magnets, and of their action at a distance, which he endeavors to confirm by experiments.

3. Of the attractive force of two magnets when the poles are altered.

4. Of the attractive force of two magnets in a position when the axes are parallel, or when the equinox of one is applied or lies on the equinox of the other.

5. Of the disjunctive or repulsive forces of two or more magnets when the similar or dissimilar poles are applied to each other; all which he explains by experiments.

6. Of the attractive forces of the magnet and iron, from its original and principal. Explained, by experiments.

7. Of the operation of the magnet on hot iron.

8. Of the vast exhalations from the magnet; their penetration through hard bodies, etc. Explained by experiments.

9. Of the method of destroying the magnetic powers in loadstones, and of some trials in chemistry. Explained by experiments.

10. Of the friction, and the power of attraction, conveyed by the magnet to iron. Explained by experiments.

11. Of the conjunctive force of the magnet upon several bodies of iron at once. Explained.

12. Of the operation of iron and magnets on the needle of the compass; and the natural operation of one needle on another. Explained etc.

13. Of other methods to render iron magnetic. Explained.

14. Of the magnetic declinations, according to the same principles, which are comprised under a calculus. He then proceeds to give several Tables, viz:

Table

1. A general table of the declination of the ocean [*sic*] from the observations of the French, English, Dutch, and Jesuits, as low as A. Kircher,[118]

from the year 1500 to1600.

2. A table of longitudes and latitudes of divers places, with the declination of the magnet, most of which are observations of John Telenius[119] in his voyage to the East Indies, by Kircher.

3. A table of the magnet's declination, from several mathematicians through Europe by the desire of Kircher.

4. A table of declinations from the observations of Martin, 1638; from Kircher of the magnetic force.[120]

5. A table of magnetic declinations in the principal parts of the Mediterranean, from Kircher; an. 1638.

6. A Table of magnetic declinations for several years, inserted in the *Acta Lipsientia;* A. D. 1684.

7. A table amongst the experiments of Ch. Wolf.

8. A table of the declination of the magnet at Paris, from 1550 to 1728.

9. A table of the same at London, from 1576–1722.

10. A table of the same at Berlin, from 1717–1725.

11. A table of the same at the Baltick from 1720–1730.

12. A table of the same observed in 4 voyages to Hudson Bay from 1721–1725; extracted from the *Philosophical Transactions,* No. 393.

13. A table of the same taken out of the German Ephemerides, of the meridian brought from Teneriff, 1675 ; from Leydekker.

14. A table of the same observed in 1708 by Fuellius[121] in a voyage to America.

15. A table of the same observed in the South Sea, 1710, *Philoso. Transac.* No. 368, from the south part of California to Guano, one of the islands of the Ladrones, passing through the meridian of London.

16. A table of the same observed by Noel in a voyage to E. India, 1706.

17. A table of the same observed by La Sonde in a voyage towards Brazil.

18. A table of the same observed in the Atlantic Ocean and Egypt, 1706; *Phil. Trans.* No. 310, p. 2433 the 1st meridian past from London[122]

19. A table of the same observed 1703 in the *Hist. Acad. Royal,* 1705; 1st meridian, Island [of] Fer.

20. A table of the same observed by Housage[123] 1704, 1705; meridian from Pico to Tenerif in *History of the Acad. Roy.* [hereinafter *Hist. Acad. Roy.*], 1708.

21. A table of the same in the *Hist. Acc. Roy.*, 1710. Merid. Pico Tenerif.

22. A table of the same in the Ethiopic Ocean, *Philosop. Transact.* 371; Merid. St. Jago.

23. A table of the same on the coast of Africa, 1721, in the same *Philo. Transactions.*

24. A table of the same taken 1706 by De la Verune, *Hist. Acad. Roy.*, 1708; merid. Tenerif.

25. A table of the same taken from Dampier.

26. A table of the same taken 1706 in *Hist. Acad.* Roy., 1710; and exhibits Dr. Halley's map with the several declinations of the compass.

Chap. 15 treats of the causes of the variation of the magnet.

Chap. 16. Is a calculation of the variation of the magnet at London to the year 1722.

PART THE THIRD

Chapt:
1. Is a comparison between the starry heaven and the magnetic sphere.
2. Treats of the diversity of worlds.
3. A continuation of philosophising of 4th finite beings, their origins from particles of the second elements.
4. Of the general chaos of the sun and planets, and their generation into planets and satellites.
5. Of the other or third element of the world.
6. Of the 5th finite.
7. Of the air or 4th element.
8. Of fire or the actives of the 5th and 6th and following.
9. Of water.
10. Of aqueous vapour or the 5th element of the world.
11. Of the vortex round the earth; the progress of the earth from the sun to the circle of its orbit.
12. Of the earthly paradise, and the first man.

VOL. 2D

Chr. 1: Contains a description of almost all the iron works in Europe, but more especially in Sweden, the account of which is very large.

The difference of the iron ore is not so great in Sweden as in other places, it being generally of the color of iron, and is distinguished by its richness and the quantity of sulphur contained in it; if the sulphur abounds in the ore, the iron that is extracted is brittle when hot, and ductile while cold; where the sulphur is not in so great quantity, the contrary happens. Therefore the best is that where it is in a mean proportion.

When the ore is taken out of the mine, it is first calcined in the following manner. They choose a declining part of the ground, and on it build a square pile of timber like a pyramid; in the midst of this they place the ore and cover the whole with sand and chalk stones; they set fire to it and let it burn 1, 2 or 3 days to 8, according to the size of the pile; by this the metal is deprived of its sulphur and arsenic, and becomes easier to separate from the earthy parts, the chalk stone is converted into lime, and are of use in the next process, which is smelting. In order to which, a furnace is built which has 4 walls; the innermost of which is of stone which will bear the fire, well cemented; the next is of a kind of grey stone; and the 3d is only sand, loose stones and rubbish rammed between the last and the outer wall which is stone and girt about with timber; it is covered to keep the workmen from the weather; at the bottom is a receptacle fitted to receive the iron as it melts, and, this being not always of the same bigness, the furnace is made to fit it every time, by plaistering it on the inside, and it is carried up to half the height of the furnace; the several diameters of the furnace are 3 *foot* at the top, 4 in the middle and 2 at the bottom, but it is no great matter what the dimensions of the lower part is, because it depends on the bigness of the focus or receptacle; this focus is in shape like a parallellogram with its 2 opposite sides equal; the stone which form this focus have sand put between the joints, which, vitrifying by the heat, close up all the crannies.

It will hold generally about 3600 lb. It is composed of 3 stories joined together with sand, which forms 3 of its sides; the 4th is an iron door not so high as the rest, so that there is a space left to clear away the scoria or dross, and let out the melted metal when it is full. This door is not shut till the 4th or 5th day after the fire is lighted. There is a door in the furnace big enough for a man to creep in at, to clean and repair, if there should be occasion. The nozzle of the bellows is inserted in one of the longest sides of the

focus; and great care must be taken that the wind be directed to the best advantage. These bellows are moved by water; everything is to be kept as free from moisture as possible, otherwise it will retard the operation. The furnace being thus prepared, it is first treated for 8, 10, or more days. When it is duely annealed, the ore is put in gradually, that is, 4 or 5 baskets at a time, each containing 40 or 50 lb, and at the same time a sufficient quantity of coals; but they are very cautious not to throw ore too much at once, for that would overcharge the furnace and hinder the heat from coming equally to all parts, and thereby prevent the metals separating from the scoria. An experienced workman will easily know whether his furnace is properly filled, and how to mix his stuff to make the best tempered iron. In the process of the work the metal boils out and sends forth great heats, which the operator remedies by stirring the whole mass and taking out any pieces that are not much loaded with metal and serve only to clog.

(Here follows a string of philosophical reasonings on the nature and cause of this ebullition.)

They judge of the state of the work within, from the color of the flames; the melted metal is suffered to run into pits made for that purpose, and there cool and harden, till fit to be removed for the next operation; everyone of these pits contain from 100 to 300 lb; before he proceeds to the next process.

(He here gives a catalog of all the smelting houses and working shops in Sweden, and takes occasion to mention some silver that was found in an iron mine in Noormark in 1728; but when they had dug 8 or 9 *yards* (Ells) deep, the silver disappeared and iron returned, so that the former seemed to be in the center of the latter. This silver ore when essayed yielded 77 lb metal out of each 100 lb mineral). The iron now goes through a 2d fusion; not in the same furnace, but one of 4 ells long, 3 broad, which has 2 (not opposite) sides open, the focus lined with plates of crude iron, and the bellows moved by water; the chimney, of a square pyramidal form. The focus is filled with scoria, 1/3 part, and pounded coal, and opposite to the foramen for the mouth of the bellows is placed the iron; when fire is put to it, it is at first but gently blown, but increased gradually to the highest degree. During the fusion the workman is continually stirring it about, lest any part of it should stick to the sides and the bottom, and not be melted. This lasts about 1 1/2 hours; when the metal is hardened, it is taken out,

the scoria cleared away, and undergoes the same operation a second time; if not purified, a 3d. Some pieces of steel will swim within fired metal and are fit to make any sharp instruments. They are sometimes melted with the rest, but it makes no difference in the goodness of the iron if taken out or no; when this is over, it is carried to the hammer where the whole cake is beat for some time, and then cut into 5, 6 or 7 pieces; these are again heated and beat 3 or 4 times according to the bigness of the piece or length required. The signs to judge of the goodness or badness of the metal must be seen in the author, it being scarce practicable to abridge them, and too tedious to transcribe. He has given a vast number of them, and prints[124] of the different grams of the iron when broken.

He mentions another sort of ore, not found in mines, but marshy grounds towards the north of Sweden, in Angermania & Delecarlia; of which are several sorts; of one black and good for little, another greenish, and another dark red which is the best and contains 49/100 parts of iron. The earth is known to contain this mineral by the great number of little hillocks in the field; and a large quantity of Gramen palustre; and also the ponds nigh having a thick fat tenacious substance or skin over them; and by thrusting a stick into the ground, when, if you feel a sensation like as when you stir it in a tub of salt, you may safely conclude there is metal contained there. The earth is dug up in summer when the marshes are able to bear workmen, in the autumn following it is fit for working, when it goes through the operations of cleaning, smelting and refining till fit for use. This is very hard when cold, and easily made steel by immersion in cold water, when heated again.

Another sort is found at the bottom of ponds, which has this good quality that when cleared away, yet, in process of time, the mineral is renewed. This is calcined before smelted. There is another sort called the Mund[125] in Sweden, formerly found in the reddish or bluish sand near ponds and in rough places. This is of use in making locks, keds, hinges, nails, patten rings, etc.; and therefore great quantities of it is sold.

But the iron most esteemed is found in Danmore; the ore is heavy, blackish, and looks like iron itself, and so rich as to contain 2/3 metal. Here follows the German and French methods of smelting and refining the ore, which are the same, with some small difference in the structure of the furnaces. He then gives a catalog of [ores in different countries].

The vein at Leodicum (Liege) is commonly red and yellow. The ore of Bressegia under the Rep. of Venice has no sulphur; the iron is therefore brittle, but from this a very good sort may be separated which is smelted without any previous calcination; but the first must be calcined before any other process can be performed upon it. The iron veins in England are discovered by boring the ground. They sometimes lie very deep; some upon mountains, which is generally poor; some in marshes, very rich.

He then describes several works in England, with the methods of making guns, which latter are chiefly in Sussex, Kent, near Tunbridge; and then follows short sketches of those in Maryland, Pennsylvania, with a map of Siberia and all its copper and iron works; of the Norwegian furnaces, those in Silesia and Saxony, those in Hercynia, Stiria & Carinthia. The ore found near Saltzburg is black, partly brown and partly yellow; it is very plentiful in the neighboring mountains. He made some attempts to try the cheapest way of supplying fuel by mixing wood and combustible earth together, but an exact calculation found the old way with coal best.

The Indians make their steel by burying the iron after it is hammered; when it has lain sometime, they take it up and peel off the scale, then bury it again, and repeat this 2 or 3 times; then what remains is steel. The general method of hardening the iron into steel in the other places, is to heat the iron red hot, hammer it well, and then throw it into cold water, where it hardens into steel. Then follows other methods of making steel which have but little difference in the principal work; perhaps some variation in building the furnaces. And likewise several experiments concerning the softening, melting, and other preparations of iron, from Mr. Reaumur.

The second Class begins with several ways of trying what quantity of metal is contained in the ore. By the loadstone; and several ways of fusing it; then how to separate any gold or silver that may be with the iron. The goodness of the metal may be known by the grain and color when broken, as well as its weight, toughness, or frangibility; for if it has a great many large shining particles, it seems not to be well refined; but the more sure way to judge of the fineness, is from the appearance it makes when broken, which he gives from Mr. Reaumur with prints of the different grains; and from the same author he takes the character of steel.

Then follows the characteristics of several mines in various parts of Europe. As Suecia, Sileasia, England etc., and where iron has been renewed in old exhausted mines.

Next is a dissertation on the Lapis Hematites & Schistus, or cleaving stone, with the places where they are found, and how much metal they contain.

The next chapter is chiefly a preparation of iron and steel, as limatura Martis et crocus Martis aperiens, crocus Martis astringens, crocus ad vitrarium usum, crocus Martis vitriolatus et saccharinus, crocus Martis antimoniatus, Mars diaphoreticus, Regulus Martialis vel chalybeus, tincture. Martis astringens, extract. Martis astringens (artificial mineral waters) flores chalybis et Martis, oleum Martis vel sal Martis.

Next is a dissertation upon the hematites and its preparations, and several observations about the specific gravity and increase of the weight of iron; the various effervescences, changes of colors, and precipitations made by iron; vitriol of steel, etc.

General accounts of the mixing iron with other metals, and sulphur; with tables of the expansion of iron by heat. The last paragraph is a short account of most mineral and acidulated waters, whether lakes, running waters, or fountains, collected from divers authors.

VOLUME THE 3D

This volume is divided into three classes, and treats of copper and its preparations. The first begins with the method of preparing it at Falun, which is performed in the following manner:

The ore, when taken out of the mine, is calcined in an open furnace to clear it from the sulphur contained in it and then it is fused in another furnace; when this is over, it then undergoes 5 calcinations more, to prepare it for the second fusing, in order to separate the metal from the earth, which it does easily or with difficulty, according to the perfection of the calcination. This is again melted several times, to obtain the degree of purity designed.

His descriptions through the whole volume are very elaborate, both describing in plates, accurately engraved, as well the several sorts of furnaces as every tool and instrument, even to the minutest, used in every operation; all which has very much raised the price of the work.

There follows the several ways of precipitating copper with iron. In the new mine found at Cuprimontia in the year 1629,[126] the ore does not want any previous calcination but is immediately carried to its first liquation, that is, into copper stone, which is afterwards calcined generally 11 times; but, if then the metal does not easily separate, it is burnt 2 or 3 times more; if any stones remain untouched at the first fusion, it is laid by till a sufficient quantity be got together, which then undergoes the several processes of liquation and calcination; for were it to be mixed with that which had already been separated, it would retard the work and endanger the spoiling the whole.

The methods in other places differ very little from this, only more or less calcinations are required according to the nature of the stone.

In many places the stones dug out of the mines have the figures of divers animals as well as plants delineated on them, of which he has given specimens in 4 or 5 of his plates.

To separate the silver that may happen to be found amongst the copper, they mix about thirty pound weight of lead with every one hundred and ten pounds of the other, and melting them together, the lead, which runs into its proper receptacle, carries with it all the more precious metal.

He then proceeds to give several accounts of this process in Hungaria, Guttenburg, Heeksted, Grundhall, Hyrcynia and Rearberg,[127] Gosslaria, from Kellner, Agricola and divers other authors.

Before he begins the manner of making brass, he gives a short account of the lapis calaminaris, which is dug out of its own mine of a yellowish brown color; that which looks red or blue is not good. The heaviest, he says, is esteemed the best. After it has been burnt and then reduced to powder, it is of use in making brass.

Brass is made by mixing this lapis calaminaris with the copper, and melting them together in earthen pots made on purpose for that operation. When both are melted, the workmen let them remain in that state at least an hour, whilst he is continually stirring it, that so every part may be equally fused and when no part is left unmelted, it is suffered to cool and then it is cut into small pieces, which are afterwards heated nine times and pressed into plates in a mill between two cylinders. This heating restores

its prestine tenacity and malleability; for otherwise it would be so brittle as not to bear the hammer. The brass when it is thus prepared is fit for use.

Then follows the several processes practised in England, Gosslar, Tirole etc., with many other places.

He then proceeds to give directions for the mixing [of] other metals with copper for the use of artifers who cast bells, and those who cast statues, etc. These are mostly taken from the *Dictionaire Universelle de Commerce*. He also directs the making [of] speculums, yellow and white metal, and shows how to color it like gold or silver.

He next treats of the different sorts of copper, the methods of trying its goodness, the various sorts of pyrites of which he has given plates, the several ways of proving copper by menstruums, which is easiest to work upon; what sort of ore is richest; what quantity of silver is contained in any parcel of copper, and abundance of other experiments of the like nature, too long and numerous to mention here; and being also abundance of receipts, the whole must be read to render them intelligible.

He next gives a large collection of preparations from copper, taken out of other authors. The first is of verdigris, with the several ways of preparing it. Then he treats of ultramarine blue, aes ustum, crocus Veneris, vitriolum and chrystallus Veneris, several tinctures of spirits of copper, the oil of copper, sulphur and the flower of it; all which with many others he has with great pains and industry transcribed from several chemical writers (From an MS in the British Museum).

Nova Acta Eruditorum

Principles of Natural Things, that is, of new attempts to explain philosophically the phenomena of the elementary world. By Emanuel Swedenborg, Assessor of the College of Mines of his Sacred Majesty and of the Kingdom of Sweden. Dresden and Leipzig, at the expense of Frederick Hekel, 1734, fol. Vol. I, 5 alphabets, 28 copperplates. Vol. II, 4 alphabets and 4 sheets; 36 copperplates. Vol. III, 5 alphabets and 19 sheets; 89 copper plates.

In the first volume of this work, the illustrious author undertakes to set forth in the most complete way, the unique system which he has formed in respect to a philosophical explanation of the elementary world. The task he has set before himself is to establish philosophical principles,

from the first simple in our universe to its last compound, from the least invisible to the first visible, and then on to the paradise of our earth; and this, as he judges, from one end, by means, to a second end, together with their connection.

He fears lest at the very threshold of his philosophy, his readers will be at once deterred when they see things that are foreign, as it were, and alien to previously received opinions; and likewise, when they meet with terms such as *Finite, Active,* and *Elementary,* which are as yet unknown in philosophical works, that is to say, which have not previously been applied to mechanics, geometry, and the elementary world. For this reason he is induced to present, in place of a preface, a summary of his philosophy and a key; and, when the work is finished, he repeats this in an Appendix.

The summary is as follows: Since nature has declared for herself the law that she shall advance by the shortest path, and shall not pass from one thing to another save by a passage through intermediates, it necessarily follows that all things in the universe have taken their origin from one simple; that is, from a primitive cause; and this in such way that derivative entities [were] arising from the simple, yet contained their primitive cause within themselves as being derived to themselves; and thus, that there is no cause save that which has been propagated from the primitive cause by continuous engrafting, as it were. *And since the universe leads its origins and increments through a certain connected and contiguous series from the first or one end, by means, to the other; and since the cause was present* (we use the author's own words) *before anything in the series is produced, and indeed the efficient and active cause, therefore, there must be a passive, there must be an active, there must be a compound or elementary, which is produced by the two; therefore, if there is a compound it must come from two principles, an active and a passive,* etc. [Preface].

Thus, the illustrious author believes that since the same principles are latent in derivative entities, as are present in the primitive, we can safely make conclusions a posteriori and by truly analytical reasoning, from the visible effects of nature to her invisible and prior effects and to the entities themselves, both passive and active, and also to that verimost cause which lies within them all.

It being our desire to place before the reader an idea of this philosophy, we can perhaps satisfy this desire in no better way than by closely following, so far as may be, the footsteps of the author who, as we have already stated, himself gives a synopsis of his system. Commencing then from the first simple, he says:

(1) In the simple is an internal state, and consequently, a conatus tending to a spiral motion. (2) In the first finite arising therefrom there is a spiral motion of the parts; thus, there is a like motion in all elementary finites. (3) Hence, in every finite there arises a progressive motion of the parts, an axillary motion (i.e., a motion according to or around an axis), and, if nothing hinders, a local motion. (4) If there is local motion, an active arises, one being like another, so that they differ only in degree and dimension. Finites, therefore, and actives, he says, have the greatest similarity with each other, so that he who knows the nature of one finite *ipso facto* knows the nature of all; and the same is true of actives. He derives their motions—the progressive, the axillary and the local—solely from the spiral motion of their parts, and he denies the existence of any motion that is more simple, or more fitted for the unfolding of nature. In a few words, *In the simple, wherein is nothing substantial that moves therein nor any medium wherein motion may exist, in place of mechanical and geometric motion, we must conceive, by a kind of simile, of there being pure and total motion* (these are the author's own words),[128] *that is, state and the thence originating conatus from like quasi motion to like quasi motion, wherein lies the one only cause and primitive force of all that afterwards comes into existence* [Preface].

And now, if the reader please, let us take a closer view, and briefly relate the order of subjects as this is set forth in the work itself. This first volume is divided into three main Parts.

In the first Part, chapter I,[129] the author treats of the means of arriving at true philosophy. These means are laid down as being Experience, Geometry, and the Faculty of Reasoning. By a true philosopher, the author means one *who, by the above mentioned means would be able to come to causes themselves, and to the knowledge of things in the mechanical world which are invisible and remote from the senses; to the end that he may then reason ex priori from principles, that is to say, from causes, concerning the world and its phenomena, physical and chemical and metallurgical, and concerning all other matters*

which are subject to the empire of mechanics; and so, from a center, would be able to measure out the circuit of the whole mundane system and its mechanism and philosophy, etc. After some intervening remarks, he concludes as follows: *If elementary nature could at last thus be brought forth into the light, and then the mineral, the vegetable, and finally the animal kingdom, what fruit would not the world then enjoy!* [I, i, 4]

He judges, however, that no mortal can arrive at true philosophy such as he describes it, save he who is said to have been in perfect integrity, that is, the first man, he who was created before the existence of vices, and in accordance with the whole art, image, and connection of philosophy and of the mundane system. Speaking from his System, the author discourses concerning the uncorrupted state of the first man. The delights of that man, he says, consisted, in accordance with all reason, in the fact *that the end of his delights, delights which he conceived wholly from the contemplation of the world, so perfect and gladsome, which had been left for him and his posterity after him, and from the delightful perception by the senses and their organs, of the motions existing in all the elements—was the love of the Deity* [ibid., ad fin.]. Furthermore, he conceives the first man to have been so formed that he was a most perfect being, material and active, *all whose parts conspired to the reception of the motion of all the elements, and when received, to their successive conveyance, by contiguity, to the most subtle active, that, namely, wherein was a continual connection of ends with means,* etc. [ibid., ad med.].

From this he infers that the first man possessed all philosophy as being natural to him, and all experimental science, as being acquired in a short time by the mere senses, etc. On the other hand, in the perverted and imperfect state in which men are now living, nothing can be investigated without means, experiments, geometry, the faculty of reasoning. But we must proceed.

2. He then presents a philosophical reasoning concerning the first simple of the world and of the natural things thereof, that is, concerning the first natural point and its existence from the infinite (I, ii). The author gives the following definition of this point: *that it is the simple and first entity existing from the infinite by means of motion, and thus, in respect to existence is as a medium between the infinite and the finite* [§ 6]. He then explains its essence more fully, saying that this natural point is the same as the mathematical point or the point of Zeno. Let us see how the illustrious

author endeavors to prove this: *For the world is geometrical or mechanical* (he says). *Nature modifies herself by means of mechanism, that is, by means of her own rules; therefore, the same beginning must be laid down for the world as for geometry; the same point is the first of the world because the first of geometry, or it is the first of geometry because the first of the world. Geometry is the law and the essential attribute of every individual thing in the world, that is to say, of the whole world; and mechanism is the mode whereby the world acts or is actuated. Hence the point is common to both, because both flow from the same origin. Thus both acknowledge some entity prior to and outside themselves, and as a kind of seed of themselves, from which they are conceived and by which they afterwards exist and subsist. Thus, since these two, the world and geometry, are from the same origin, seed and parent, therefore, it must be concluded that they are from the same point. The difference is, that the one point, or that of the world, is called the Natural Point, and the other, or that of geometry, the Mathematical Point* [§ 7]. As to what is to be thought concerning the above proof; this we leave to others, without any study of its parts.

The author then devotes much space to expounding the properties of the simple, its internal state, its conatus to spiral motion, etc., of which we have already spoken. *This point,* he asserts, *is produced by the infinite immediately (§* 11*). Nothing that is attributed to compounds can be attributed to it save by analogy* (§ 19). *In its pure and most perfect motion are contained all those things, both active and passive, which finite things finite and whereby the latter are finited throughout all their series* (§ 20).

In paragraphs 21–24, he explains the spiral motion more fully. *When the subject treated of concerns the natural point, a point which escapes the power of the senses* (he says) *nothing in the way of experience can be brought forward whereby the belief in principles may be confirmed, except the fact that Nature, which is a motive force* (the words are the author's own) *desires nothing more freely than to flow into the spiral figure of motion, and is able so to flow; by this figure, every celerity through all its degrees is accomplished with the utmost freedom and ease; and to it Nature seems to have applied all her mechanical force and power,* etc. [§ 23].

[*Continued in* The New Philosophy *CVII (July-December 2004, nos. 3 &4): 129–159*]

ENDNOTES

111. What follows in the review is simply a transcript, with slight shortening, of the list of contents given by Swedenborg in his Introductions to *Iron* and *Copper.*

112. A superior kind of iron, formerly peculiar to Sweden

113. That is, in America.

114. That is, the Japanese and Chinese.

115. This should be 314. The reviewer follows Swedenborg.

116. *Commercium Litterarium* ad Res Medicae et Scientiae Naturalis Incrementum Institutum quo quicquid novissime observatum, agitatum, scriptum vel peractum est, succincte delucideque exponitus. (A Literary Interchange, Instituted for the Increase of the Medical Art and of Natural Science; wherein is set forth succinctly and clearly all that has been newly observed, discussed, described or done.) This journal consisting of 8 pages 4to (later increased to 16) handsomely printed, was published weekly in Nuremberg by a Society for Literary Interchange in Physics, Technical Matters and Medicine. Its editors included some of the prominent learned men of Germany. It was commenced at the end of 1731 and continued to the end of 1745.

117. "An account by James Theobald Esqre, of a book entitled Emanuelis Swedenborgii *Principia Rerum Naturalium,* sive novorum Tentaminum phoenomena mundi elementaris philosophici [sic] explicandi. Dresdae & Lipsiae, 1734; in 3 Tom. in folio." This is the title of an English MS of 15 pages now preserved in the British Museum. It is endorsed on the back: "Mr. Theobald's Abstract of Swedenborgii Principia Rerum Naturalium, 3 tom. fol. March 9, 1737. Entered in R. B." Of James Theobald himself, little is known. In 1725 he was elected a Fellow of the Royal Society; and in 1743, a Director of the Bank of England, a position to which he was re-elected several times thereafter. Interest in civic welfare is indicated by his serving on the committee of a hospital (1747–50), and also of a Society for the cultivation of the arts, manufactures and commerce (1755); and, that he was interested in the promotion of scientific research, is shown not only by the present paper, but also by the active part which he took in procuring the examination of a woman without a tongue who yet spoke distinctly (*Phil. Trans,* 1749 n. 484, p. 621). He died in 1759. It is possible that Theobald's review was written for the Royal Society, to which body Swedenborg had sent a copy of his *Opera Philosophica et Mineralia.*

118. Theobald nearly always writes "Kercher." "As low as" " means "as far back as."

119. This should be "Telierus."

120. That is, Kircher's book *On the Magnet.*

121. In Swedenborg's work this is "Fueilleus."

122. That is, the first meridian being passed through London.

123. Houssaye. . . . Peak of Teneriffe.

124. These prints were apparently omitted by Swedenborg. At any rate they have not been found in any known copy of *De Ferro,* including those in the British Museum and in the Library of the Royal Society. See *De Ferro* p. 96, and the Swedish translation, p. 119 note.

125. An error for *Osmund.*

126. An error for "1696."

127. "and Rearberb" is an error; it should be " Andreasberg."

128. Here and in other places, the reviewer uses neither quotation marks nor italics. The latter are used in the translation to indicate direct quotations from Swedenborg.

129. The reviewer's references are to the pages of the original; but we have changed these as shown in the text.