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Speculative Geology

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We are not at peace with nature now. Whether it is the record-setting rain on the east coast or the raging wildfires in the west, distant news of melting permafrost or bleaching coral reefs, or the unexpected eruption of Mount Kilauea a few miles from here, things seem increasingly, and increasingly violently, out of control. I would like to suggest that there are resources in Schelling's *Naturphilosophie* we can use in the twenty-first century to help us think differently about both the power of nature and our own relationship to it. Although Schelling saw himself, and was seen by many, as antagonistic toward the mechanical science of his own time, it would be a mistake—and a missed opportunity—to see his view as a mere Romantic reaction. It is a speculative rethinking of the idea of nature itself that finds a place for even those phenomena which seem most distant and alien. Schelling described his philosophy of nature as "speculative physics" both to distinguish it from what he calls the dogmatic or mechanistic model of nature, and to announce a new approach to natural science, concerned with the original causes of motion in nature (SW III: 275). Since every "natural phenomenon ... stands in connection with the last conditions of nature" (SW III: 279), speculative physics can bring us to an understanding of nature as a system. Geology presents an illuminating case of this approach, as can be seen from Schelling's characteristically enthusiastic introduction to a paper published by Henrik Steffens in Schelling's *Journal of Speculative Physics* (*Zeitschrift für speculative Physik*) on the oxidization and deoxidization of the earth.[1] After praising Steffens' work on a new and better founded science of geology, Schelling reflects darkly on the too long dominant mechanical approach to geology. However, a new light has dawned, he

1 "Vorbericht zu Steffens Abhandlung über den Oxydations- und Desoxydationsproceß der Erde," *Fernere Darstellungen aus dem System der Philosophie*, SW IV: 508-510.

declares, and as is well known, there are two ways forward—one can proceed from the lowest to the highest processes, or from the highest to the lowest. Steffens has elected the first method, and promises to connect the most general chemical processes to the "highest dynamic forces" (SW IV: 509), including the most powerful, the volcanic.

Like many an editor before and after him, Schelling then proceeds to tell Steffens what he should have written:

> We dare to hope that the author will take the other path, and that he will, by means of fortunate and carefully observed correspondences between the way magnetism expresses itself at the different latitudes and the lines which stretch between volcanoes on the earth's surface, be able to join the two extremes in a general dynamic process of the earth, and thus lead to the proof for the dynamic graduated series in the construction of every real product in general (SW IV: 509).

In other words, Schelling wants a speculative geology, and hints strongly at the vital role of magnetism in constructing it. Already in the introduction to the *First Outline of a System of the Philosophy of Nature* he had argued that since nature is originally identity, duplicity is its condition of activity:

> Thus it is the highest problem of natural science to explain the cause that brought infinite opposition into the universal identity of Nature, and with it the condition of universal motion .... But we know of no other duplicity in identity than the duplicity in magnetic phenomena. It can only be noted in anticipation that magnetism most likely stands on the boundary of all phenomena in Nature—as a condition of all the rest (SW III: 161).[2]

What does Schelling hope for from a speculative geology? First, it would form the basis for all other sciences. In 1802 he writes: "Geology, when it has been fully developed, will be the history of nature, the earth merely its means and starting point. As such it would be the truly integrated and purely objective science of nature, to which experimental physics can only provide a means and transition" (SW V: 329-220).[3]

Secondly, a speculative geology would provide an illustration of the dynamic approach to physics, which is described in the *First Outline* as "this great interdependence of all nature" (SW III: 320).[4] This dynamic system would show the same forces as animating the inorganic and the organic realms.

2 F. W. J. Schelling, *First Outline of a System of the Philosophy of Nature*, trans. Keith Peterson (Albany: SUNY Press, 2004), 117.

3 F. W. J. Schelling, *On University Studies*, trans. E. S. Morgan, (Athens, Ohio: Ohio University Press, 1966), 128.

4 Schelling, *First Outline*, 228.

Finally I will argue that both Henrik Steffens' Schelling-inspired *Contributions to the Internal Natural History of the Earth* (*Beyträge zur innern Naturgeschichte der Erde*, henceforth referred to as simply *Beyträge*)[5] of 1801 and Schelling's own texts point to the conclusion that a true speculative geology would lead to the idea of the unconditioned whole, for only the unconditioned can be a final ground. This unconditioned ground will embrace all finite, conditioned beings.

Henrik Steffens

The *Beyträge* was Steffens' first major publication. We have an unusually detailed picture of its genesis, thanks to his ten-volume autobiography, *What I Experienced* (*Was ich erlebte*).[6] Steffens' father was German and his mother Danish. His early life was marked by an intense search for a vocation, which brought him by means of a study grant from the Danish Nature Research Society to Bergen in Norway. The austere and rocky landscape of the Sammanger-Fjord caused him to fall into a deep depression, which was characterized by "a feeling of abandonment [and] a fearsome loneliness"[7]:

> The region between Bergen and Sammanger-Fjord offered a picture of the most blood-curdling confusion .... This was one of the most frightening regions I have ever encountered .... Huge shattered boulders covered the barren mountains, and the wildly plunging floods were concealed behind the boulders and came foaming around them. The whole presented a horrifying mix of chaotic rigidity and wild unrest. Every spark of connection seemed to have vanished from this lifeless chaos.[8]

Almost exactly fifty years later, Henry David Thoreau had a similarly disorienting experience while climbing Maine's Mount Ktaadn, one that permanently affected his understanding of nature and caused him to reject Transcendentalism's more Romantic view:

> The mountain seemed a vast aggregation of loose rocks, as if some time it had rained rocks, and they lay as they fell on the mountain sides, nowhere fairly at rest, but leaning on each other .... Aeschylus had no doubt visited such scenery as this. It was vast, Titanic, and such as man never inhabits. Some part of the beholder, even some vital part, seems to escape through the loose

5 Steffens, *Beyträge zur innern Naturgeschichte der Erde*, "Erster Theil" (Freiberg: Verlag der Crazischen Buchandlung, 1801). Primary Source Edition, reprinted by Nabu Public Doman Reprints.

6 Steffens, *Was ich erlebte. Aus der Erinnerung niedergeschrieben*, 10 vols. (Breslau: Josef Max und Komp, 1841).

7 Steffens, *Was ich erlebte*, vol. 3, 62.

8 Steffens, *Was ich erlebte*, vol. 3, 113-114.

> grating of his ribs as he ascends. He is more lone than you can imagine.[9]

Thoreau's experience on Mount Ktaadn helped provide the inspiration for what some scholars call his wilderness philosophy, which became a complete revisioning of nature and man's place in it. Steffens too seemed consumed with the need and desire to rethink traditional ideas about the earth. He decided that to accomplish this, he needed to complete his education, which he chose to do in Germany, receiving a doctorate in mineralogy from the University of Kiel in 1797. In addition to mineralogy he plunged into the study of literature and philosophy and found himself fascinated with the latest sensation, Schelling's *Ideas for a Philosophy of Nature*. He called reading it the decisive turning point of his life:

> It seemed to me that I was hearing a first meaningful heartbeat in the quiescent unity, as if a divine life were awakening, to speak the first hopeful words of the future consecration [*Weihe*] .... I read this work, may I say, with passion. *The World Soul*, too, I received as soon as it was published, and the most profound hope of my entire life took hold of me, to grasp nature in its multiplicity, and determined my work for the rest of my life.[10]

My purpose in this paper is to look at one part of that life's work, Steffens' *Beyträge*, which comes closest to focusing on "the great interdependence of nature" which animated Schelling's *Naturphilosophie*. It was composed in part in Jena, where he was in close contact with Ritter, Goethe and Schelling. He described this work as his breakthrough as a *Wissenschaftler*:

> That which I tried to develop in this work was the basic theme of my entire life .... Most of all I was possessed by the hope that grew ever stronger, to give the elements of physics more importance. And this epoch of my existence I owe to Schelling ... The whole existence [of the earth] ought to become history[;] I called it the inner natural history of the earth.[11]

What Steffens called the basic theme of his life, describing the inner natural history of the earth, also explains how he understands the purpose of geology. It is striking how closely Steffens' discussion of the origins of the earth parallels Schelling's in the *Ideas for a Philosophy of Nature*, a description which is itself inspired in part, as Schelling notes, by Kant's 1785 essay, "On the Volcanoes in the Moon."[12] Kant

9 Henry David Thoreau, *Maine Woods* (New York: Harper and Row, 1987), 82.
10 Steffens, *Was ich erlebte*, vol. 3, 338-339.
11 Steffens, *Was ich erlebte*, vol. 4, 286-288
12 Originally appeared as Immanuel Kant, "Über die Vulkane im Monde," *Berlnischer Monatsschrift* (*Berlin Monthly*) 1, no. 3 (1785). Cited by Schelling, SW II: 101, *Ideas for a Philosophy of Nature*, trans. Errol Harris and Peter Heath (Cambridge: Cambridge University Press, 1988), 79-80.

argued, and Schelling agreed, that "the earth only gradually evolved from a liquid to a solid state, and that the change gave rise to the production of vapors which expanded in the heat set free by this process, and so threw up matter in great masses as mountain ranges. They themselves decomposed and compressed one another until the air, having come into equilibrium with itself, rose of its own accord. Part of it, however, precipitated as water, which, on account of its weight, soon poured into the craters of that universal eruption. Only now did it break its own way through the interior of the earth, and so gradually by its flow formed the regular shape of the mountain ranges, and by continual floodings, in the course of the centuries, brought about those regular strata of calcareous, vitrified or petrified vegetable or animal bodies in the interior of the mountains" (SW II: 102).[13]

For Steffens the different strata to be found in the mountains are of two main types, carbon-based or nitrogen-based. After a detailed discussion of the geological differences that in his view constituted the two great oppositions, that of plant life and animal life, he concludes by observing that despite the obvious differences, inorganic nature and organic nature have the same structure. This symmetry "allows us to suspect a deep rooted opposition of actions. We have found it in the dead residue of completed actions through observation .... [Now] I climb slowly out of the grave of nature, to find its restless, active life."[14] Steffens has examined the bones, as it were, and found patterns of interdependence, but these must also be in evidence in organic nature. He argues that the "opposed series" he has discovered are also maintained in nature in general, which through their remaining residues is still always capable of reproducing these opposed series. He declares that this result, despite being found on the lowest level of observation, can still serve us as a secure guide (*Leitfaden*).[15]

He thought of himself as striving for a harmony between philosophy and science, but this goal was fulfilled in the way of which Schelling had been critical in his preface, e.g., from lowest to highest. Indeed, the bulk of the *Beyträge* is a detailed account of (an unsympathetic reader might say, a slog through) many empirical observations, and along the way, discussions of other related scientific contributions made by Lavoisier, Werner, Fourcroy, Humboldt, Kielmeyer, Parmentier, Ritter and many others. Out of the welter of observations about carbon, nitrogen, and the metals, with which he was particularly fascinated, we learn that a philosophical natural science is not primarily concerned with empirical objects, but rather with the "original organizing *spirit* of nature, which spoke to us from its works; but the key to the secrets of its production must be sought in the inner depths *of our own spirit*."[16]

This is why the purely empirical chemist is bound to fail. "It is a truly wonderful characteristic of human nature," Steffens observes dryly, "to stick to a

13 Schelling, *Ideas*, 79.
14 Steffens, *Beyträge*, 34-35.
15 Steffens, *Beyträge*, 34.
16 Steffens, *Beyträge*, 90.

chosen method come hell or high water."

> Inspired by the great strides made by the application of mathematics to the movement of heavenly bodies by Kepler and Newton, the men who succeeded them came to believe that even the innermost secrets of nature could be reduced to mathematical formulas. Even if Lavoisier had largely succeeded in reducing many chemical processes to the interactions of just a few, still it was a mistake on his part to give into the hope that by means of chemical analysis one might be able to penetrate the holy ground [*Heiligthum*] of organic life.[17]

Lavoisier's attempts to do so shows that he failed to recognize the absolute limit of chemistry.

Steffens argues that even if it should someday prove possible to derive the entire system of chemical elements from the oppositions between carbon and nitrogen, hydrogen and oxygen—it still would remain impossible to explain this opposition itself.

> It is possible through interaction of the elements [*Stoffe*] to build limits within limits, by means of which new, still narrower and more restricted relationships develop. The chemist sees it; they arise under his hands; but how can he explain it? His elements [*Stoffe*] are heavy. That which is heavy is inert.—His analysis *kills* nature, the living principle slips out of his hand, and the dead mass—unseen, indeed—remains to him as mere stuff [*Stoff*]—*What could bring this stuff to life?*[18]

Earlier in the text, Steffens had hinted that the source of life cannot be sought chemically, but only through a leap (*Sprung*),[19] not further defined except to say that it involved a turn inward (*nach innen*), an echo of his full title, *Contributions to the Internal Natural History of the Earth* (*Beyträge zur inner Naturgeschichte der Erde*). With respect to geology, if the question becomes how the earth and everything on it arose, we need to ask: how do qualities arise out of a homogenous mass? By opposition. How does this opposition arise? The answers to this question cannot be ascertained by experience, therefore we need *Naturphilosophie*.[20]

As we know from Schelling's remarks on Steffens' publication on oxidization, he hoped that Steffens would "by means of fortunate and carefully observed correspondences between the way magnetism expresses itself at the different latitudes and lines which stretch between volcanoes on the earth's surface, be able to

17 Steffens, *Beyträge*, 37-38.
18 Steffens, *Beyträge*, 80.
19 Steffens, *Beyträge*, 41.
20 Steffens, *Beyträge*, 96.

join the two extremes in a general dynamic process of the earth" (SW IV: 509). This idea is developed through considering the magnetic properties of the various metals and an elaborate account of their relationship to each metal's density (or weight), ductility, coherence and expansibility. Steffens gives as many examples as he can, while admitting that there is some missing and contradictory information in the case of the more rare metals. He concludes that his research revealed that it is as if the metals "are arranging themselves, and these relationships [in the patterns he describes] are really grounded in nature, and produce the key to the laws of the properties of metal."[21] He cites the work of Ritter and Arnim, who also pursued this connection, but points out that Schelling had had the idea first:

> That Herr Professor Schelling earlier than Ritter and Arnim found a priori the idea of the connection between magnetism and the maximum on absolute coherence, and thereby led to a highly salutary revolution in natural science, is shown by a letter he wrote me, dated the 21st of October 1799, which contains the following passage: 'The circle gives me the liquid. First light about the great difference between liquid and solid here dawned on me. Consider, if the two poles A and B of a magnet *touch*, there is *no* magnetism. The *cause* of *length*, or what is the same, the cause of *solidity*, is also the cause of magnetism, and the reverse.'[22]

It is clear to Steffens that magnetism is the key to understanding the fundamental structure of the earth. He may have the claim from the *Ideas* in mind that

> ... the cause of magnetic phenomena must be related to the first active causes in Nature, or that unknown to which it is related, and which perhaps contains the reason for all its individual affinities (to iron, for example) must be spread over the whole earth (SW II: 163).[23]

Steffens develops the suggestion that magnetism permeates the earth and has a particular relationship to the metals. He waxes poetic as he explains that metals are suggestive precisely because they display the simplest properties; they are the most invariable [*unveränderlich Beharrende*] and the hardest to decompose: these characteristics demonstrate that here something is "*bound*," that in all other bodies is "*separated*."[24] Thus we are now in a position to better understand the common origin of the opposition which constitutes every polarity, by examining the case of metals.

21 Steffens, *Beyträge*, 129.
22 Steffens, *Beyträge*, 155.
23 Schelling, *Ideas*, 127.
24 Steffens, *Beyträge*, 198.

> Here is to be found united in invariant, law-governed form, that which was lost in the infinite depths of evolution, [and] seems more confused, lawless and willful. But it is certain that nature is never left in willful hands, [and] that a still, even if often dark and concealed law, holds all of the apparent chaos in its power, and it is equally certain that we must untangle the endlessly convoluted knot by beginning with the metals.[25]

Ultimately the same structures (of opposition as constitutive) must prevail everywhere, so it is understandable why Steffens insists that "the mass of the earth is the true root of life on earth."[26] and "all activity in nature is in embryonic form in mass itself."[27] The *Beyträge* then turns to what might informally be called a geography of magnetism: Steffens reflects upon patterns of the distribution of iron and the other so-called coherent metals and their distance from the equator, which leads him to state the law governing these phenomena, which again, he insists, is not artificial and forced, but *grounded* (no pun intended) in nature: the quantity and distribution of iron (as well as the coherent metals copper, nickel, cobalt, and molybdenum) stands in a direct relationship with their distance from the equator, increasing with distance.[28] These reflections lead to the formulation of his "laws" of the distribution of metals.

Steffens then launches into an almost lyrical appreciation of the pageantry and irrepressibility of life, which he points out, first began and is still most wildly prolific in the region of the equator. It is not just the profusion of organic life; most volcanoes are to be found in that region, where the primal forces that are manifested everywhere on earth are closest to the surface. This shows that both the organic and the inorganic flourish and are most active under the same conditions, and moved by the same power.

What is that power? Schelling had already anticipated, in the *First Outline* that "there must be one force that reigns throughout the whole of Nature and by which Nature is preserved in its identity" (SW III: 145n),[29] and that that one force was magnetism. Steffens is convinced that this is true; however, his regret is palpable that he cannot find compelling evidence of the presence of the power of magnetism beyond the metals.

On Magnetism in Nature

In June of 2018 an article appeared in *Current Biology* with the title "The Earth's Magnetic Field and Visual Landmarks Steer Migratory Flight Behavior in the Nocturnal Australian Bogong Moth." The abstract reads, in part:

25 Steffens, *Beyträge*, 198.
26 Steffens, *Beyträge*, 198-200.
27 Steffens, *Beyträge*, 214.
28 Steffens, *Beyträge*, 168.
29 Schelling, *First Outline*, 79n.

> Like many birds, numerous species of nocturnal moths undertake spectacular long-distance migrations at night. Each spring, billions of Bogong moths (*Agrotis infusa*) escape hot conditions in different regions of southeast Australia by making a highly directed migration of over 1,000 km to a limited number of cool caves in the Australian Alps, historically used for aestivating over the summer. How moths determine the direction of inherited migratory trajectories at night and locate their destination (i.e., navigate) is currently unknown. Here we show that Bogong moths can sense the Earth's magnetic field and use it in conjunction with visual landmarks to steer migratory flight behavior.[30]

One can only imagine how gratified Steffens and Schelling would have been to learn that Bogong moths have joined the ranks of Monarch butterflies,[31] nocturnal songbirds[32] and sea turtles[33] as creatures who have been proven to use the earth's magnetic field for navigation. Recently scientists were able to demonstrate that a variety of different fish, such as rainbow trout, zebra fish, yellow-fin tuna, and tilapia possess magnetite based magnetic receptor cells in their olfactory epilethium. In a sense they are literally magnetic themselves.[34] Even animals as large as foxes,[35] dogs,[36] and whales have been shown to orient themselves using the earth's magnetic fields.[37]

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30 David Dreyer et al., "The Earth's Magnetic Field and Visual Landmarks Steer Migratory Flight Behavior in the Nocturnal Australian Bogong Moth," *Current Biology* 28, no. 13 (2018): 2160-2166, abstract. https://www.cell.com/current-biology/fulltext/S0960-9822(18)30632-8.

31 See Jim Fessenden, "Scientists show that monarch butterflies employ a magnetic compass during migration," *UMass Med News*, June 24, 2014.
https://www.umassmed.edu/news/news-archives/2014/06/scientists-show-that-monarch-butterflies-employ-a-magnetic-compass-during-migration/.

32 See William W. Chochran, Henrik Mouritsen, and Martin Wikelski, "Migrating Songbirds Recalibrate Their Magnetic Compass Daily from Twilight Cues," *Science* 304, no. 5669 (2004): 405-408. http://science.sciencemag.org/content/304/5669/405.

33 See Kenneth J. Lohmann and Catherine M. Fittinghoff Lohmann, "A Light-Independent Magnetic Compass in the Leatherback Sea Turtle," *The Biological Bulletin* 185, no. 1 (1993): 149-151. https://www.journals.uchicago.edu/doi/abs/10.2307/1542138.

34 See Stephan H. K. Eder et al., "Magnetic characterization of isolated candidate vertebrate magnetoreceptor cells," *PNAS* 109, no 30 (2012): 12022-12027. http://www.pnas.org/content/109/30/12022.

35 See Daniel Cressey, "Fox 'rangefinder' sense expands the magnetic menagerie," *Springer Nature, nature.com newsblog*, January 12, 2011. http://blogs.nature.com/news/2011/01/fox_rangefinder_sense_expands.html.

36 See Vlastimil Hart et al., "Dogs are sensitive to small variations of the Earth's magnetic field," *Frontiers in Zoology* 10, no. 80 (2013). https://frontiersinzoology.biomedcentral.com/articles/10.1186/1742-9994-10-80.

37 See Margaret Klinowska, "Geomagnetic Orientation in Cetaceans: Behavioural Evidence," in Jeanette A. Thomas and Ronald A. Kastelein (eds.), *Sensory Abilities of Cetaceans. NATO ASI Series A* 196 (1990): 651-663. https://link.springer.com/chapter/10.1007/978-1-4899-0858-2_46.

Steffens' argument that everything in and on the earth is ruled by magnetic forces has been considerably extended, and in a more direct way than even he could have imagined.[38]

Steffens does not doubt that these same principles could also be applied beyond the earth to a theory of the universe, but observes in a footnote that in their correspondence, Schelling told him of the imminent publication of just such a theory; therefore he finds that any further efforts on his part in this area are at present superfluous.[39]

The *Beyträge* closes with a final sentence expressing both a pious hope and a promise: "He who nature permits to find it in its harmony—he carries an entire infinite world inside himself—he is the most individual of creations, and the holy priest of nature."[40] This portrait of the true scientist/researcher seems to have made a lasting impression on Schelling. He uses a similar turn of phrase in the *Statement on the True Relationship of the Philosophy of Nature to the Revised Fichtean Doctrine* (1806) to distinguish the authentic man of science from the mere mechanic:

> For the true physicist, the one worthy of the name, the irrational is an object of treatment but not of knowledge; he has only the relationship of a technician to it; as a man of knowledge, however, and one who strives for science, he is solely focused on being; he sets being free, the true priest of nature, who sacrifices that which does not have being, so that being can become transfigured into its true essence (SW VII: 100).[41]

Was Steffens Schelling's true man of science? Certainly he was the most rigorously scientifically educated of Schelling's many admirers. Steffens himself says of their first meeting that Schelling received him "not just with friendliness but with joy. I was the first natural scientist who allied with him unconditionally and with enthusiasm."[42] Even if we do not wish to give Steffens as much credit as those who claim that he achieved a unified theory of nature "as an integrated, hierarchical and dynamically

38 Schelling also appears to have anticipated this in the *First Outline*, when in an aside in the discussion of the connection of the organic realm to the rest of nature, he remarks: "If it is certain that the force of production is intertwined in the most intimate way with the *universal* organism, then this will hold as well for *all* drives of the animal—(should we believe that a universal alteration of nature, e.g., correlates with the drive of the migratory bird, which, in the very season when the magnetic needle reverses in order to point in the opposite direction, initiates the flight to another climate?)—It has to hold for *all* drives" (SW III: 206). Schelling, *First Outline*, 138.

39 Steffens, *Beyträge*, 20n1. This may have been a reference to "Betrachtungen über die besondere Bildung und die inneren Verhältnisse unseres Planetensystems," which appeared in the *Fernere Darstellungen* of 1802 (SW IV: 450ff.).

40 Steffens, *Beyträge*, 317.

41 Schelling, *Statement on the True Relationship pf the Philosophy of Nature to the Revised Fichtean Doctrine*, trans. Dale E. Snow (Albany: SUNY Press, 2018), 89.

42 Steffens, *Was ich erlebte*, vol. 4, 76

evolving chain of being,"[43] it must be conceded that above and beyond all of its detail and many cross references, the *Beyträge*'s animating spirit is a thoroughly *naturphilosophischen* one.

The final section of the *Beyträge* contains Steffens' most sustained reflections on nature as a whole, including the claim that a geology based on magnetism (along with a meteorology based on electricity) would form the empirical basis for a *Natur-Theorie*.[44] It seems indubitable to him that since all entities on what he calls the "lowest level" (*niedersten Stuffe*) have been shown to be fully understandable only in terms of the conflict of opposed activities, a means has been found to gain insight into the perpetual strife, and "never-ceasing life of nature."[45]

Life is motion, or conflict, and just as we do not take account of the births and deaths of our cells, whose life sustains and constitutes our own larger life, so Steffens sees all the parts of the earth, each of which comes to be, exists or lives for a longer or shorter time, and ceases to be, as truly understood only as parts of that larger life which is nature. Life is the unconditioned ground which sustains all conditioned and finite creatures.

The conclusion of the *Beyträge* briefly sketches what Steffens calls the web of animal life, although he refers to these descriptions as the "presentiments of the natural researcher" rather than as completed proofs. First he argues for the existence of a formative power (*bildende Kraft*) extending throughout the entire realm of animal life: it takes the form of a web, with the lines closest together at the center, representing the simplest jellyfish and mollusks, and then widening to accommodate animals of greater and greater complexity. As the different species of animals become more differentiated, the presence of individuality also increases; in each of these life forms "nature is seeking itself."[46] How does nature produce all this variety? This is the fundamental question Steffens sees himself as posing to future natural scientists.

Finally there is the matter of having a genuine love of and openness to nature. Steffens asks how it is possible for one who has observed the endlessly changing rain and movement, the eternal play of interconnected activity, or who has so much as observed the life in still water on a warm spring day, or the lively population of a hedgerow on a hot summer day, who loves nature with true devotion, would not confess that as he was doing so he had cast a wondering glance into the endless, holy, mysterious abyss of all?[47] This high estimation of the power of observation was shared by Schelling.[48]

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43 Andrew D. Wilson, "Introduction," in *Selected Works of Hans Christian Oersted*, ed. and trans. Karen Jelved, Andrew D. Jackson, and Ole Knudsen (Princeton: Princeton University Press, 1998), xxvii.

44 Steffens, *Beyträge*, 270.

45 Steffens, *Beyträge*, 269.

46 Steffens, *Beyträge*, 306.

47 Steffens, *Beyträge*, 306.

48 "The natural scientist belongs in the country .... Observation is still the best. How much is there to observe from early morning right up to the complete silence of nightfall outside, from living through one

What do we gain from *Naturphilosophie* in the 21st century? The towering scientific achievement of our time, quantum physics, has been claimed to be

> ... best understood by departing from the traditional scientific realism which works well enough for understanding non-quantum physics. The point of a quantum theory is neither to conform our thought to the world by describing or representing it the way it is nor to create or mold the world, but to tell us what to make of it.[49]

Even experienced physicists struggle to find the words and images to convey the reality and meaning of dark matter. However powerful these theories may be for grasping sub-microscopic or galactic reality, this is not the world we live in. Contemporary science has led us in directions almost aggressively unrelated to what we can conceptualize, yet physics has remained privileged in our minds as that branch of science which comes closest to genuinely grasping reality. The implication that reality cannot be known and it is pointless to try is both the product of and contributes to our estrangement from nature.

The spirit of *Naturphilosophie*, as I have identified it in Schelling, Steffens, and Thoreau, offers not the most scientifically accurate description of nature (Schelling knew well how quickly scientific discovery proceeds), but rather that which answers best to what Steffens called the "depths of our spirit," once we have been confronted by the power and violence of a nature that can seem alien and to have no place for us. A Schellingian theory/science of the earth would be most powerful and useful at the scale of our human bodies and the range of our powers of observation. One example can be found in the current research on the movement of the magnetic North Pole, which has garnered the most public attention at the rather homely level of understanding and accounting for the effects of this movement on the programming of GPS-dependent technologies. Most people at least occasionally rely on GPS, and the idea that the magnetic field of the earth is changing must be unsettling. We may not have magnetic receptor cells in our noses like the yellow-fin tuna, but we have them in our pockets, and arguably we are just as dependent on them.

There are two complementary explanations for why this movement of the magnetic pole is taking place. The earth's magnetic field is generated by the dynamo effect, discovered by Gary Glatzmaier and Paul Roberts in 1995, which arises from the interaction between the solid inner iron core of the planet and the liquid outer core of molten iron, which is electrically charged and in constant chaotic motion.[50] This

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long summer's day .... Here I have observed things about the most universal effects of nature." SW IX: 26, Schelling, *Clara*, trans. Fiona Steinkamp (Albany: SUNY Press, 2009), 19.

49 Richard Healey, *The Quantum Revolution in Philosophy* (Oxford: Oxford University Press, 2017), 236.

50 See NASA, "Earth's Inconstant Magnetic Field," *NASA Science* (online). https://science.nasa.gov/science-news/science-at-nasa/2003/29dec_magneticfield/. "Using the equations of

theory reflects the power and dynamism of the most fundamental forces in nature just as Schelling and Steffens depicted it, as well as the idea that although law-governed, natural forces such as magnetism emerge from an unknowable chaotic origin.

The second theory attributes some or all of the movement in the earth's magnetic field to climate change, specifically the changes in the pattern of distribution of water on the earth's surface due to drought and the melting of the polar ice sheets. Surendrik Adikhari and Eric Ivins, authors of "Climate-Driven Polar Motion 2003-2015," in *Science Advances* in 2016, warn that the connections they have discovered between polar motion and the movement of water on the earth's surface have "broad implications for the study of past and future climate."[51]

This theory could be employed to illustrate the fragility of nature and the direct interconnectedness of human activity with its most fundamental forces. Our actions have implications for the stability and maintenance of the earth's magnetic field, to the extent that we contribute to climate change. This perspective has the potential to endow the claim that the life of nature is our unconditioned ground with a newly vital significance, and help to return us, just as Schelling always intended, to a recognition of our place in nature that relies upon the recognition and acceptance of the commonalities among all parts of that larger life.

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magnetohydrodynamics, a branch of physics dealing with conducting fluids and magnetic fields, Glatzmaier and colleague Paul Roberts have created a supercomputer model of Earth's interior. Their software heats the inner core, stirs the metallic ocean above it, then calculates the resulting magnetic field. They run their code for hundreds of thousands of simulated years and watch what happens. What they see mimics the real Earth: The magnetic field waxes and wanes, poles drift and, occasionally, flip. Change is normal, they've learned. And no wonder. The source of the field, the outer core, is itself seething, swirling, turbulent. 'It's chaotic down there,' notes Glatzmaier. The changes we detect on our planet's surface are a sign of that inner chaos."

51 Surendrik Adikhari and Eric Ivins, "Climate-Driven Polar Motion 2003-2015," *Science Advances* 2, no. 4 (2016). http://advances.sciencemag.org/content/2/4/e1501693. The full abstract for their article is as follows: "Earth's spin axis has been wandering along the Greenwich meridian since about 2000, representing a 75° eastward shift from its long-term drift direction. The past 115 years have seen unequivocal evidence for a quasi-decadal periodicity, and these motions persist throughout the recent record of pole position, in spite of the new drift direction. We analyze space geodetic and satellite gravimetric data for the period 2003–2015 to show that all of the main features of polar motion are explained by global-scale continent-ocean mass transport. The changes in terrestrial water storage (TWS) and global cryosphere together explain nearly the entire amplitude (83 ± 23%) and mean directional shift (within 5.9° ± 7.6°) of the observed motion. We also find that the TWS variability fully explains the decadal-like changes in polar motion observed during the study period, thus offering a clue to resolving the long-standing quest for determining the origins of decadal oscillations. This newly discovered link between polar motion and global-scale TWS variability has broad implications for the study of past and future climate."