

The Body, Soul and Spirit of the Earth

J. Duncan Keppie

2367 Ridge Road, Hortonville, Nova Scotia, B4P 2R3, Canada

johnduncankeppie@gmail.ca

“The findings of true natural science everywhere are in line with the results of spiritual scientific investigation”.... “Never are there any grounds for contradictions between spiritual science and true natural science” (R. Steiner, 1911. What Has Geology to Say About the Origin of the World? Lecture in Berlin, Germany, GA 60).

“I am Man, I am the Past, the Present and the Future. Every mortal should lift my veil” (Steiner, 1918, S-3463).

SUMMARY

The Goethean method involves discovering the dynamic processes (metamorphosis, transformation) involved in various cycles (e.g. plant, animal and rock cycles) that are hidden beneath successive layers (or veils), the outer one identified by the senses. In this context, a comparison of Steiner’s threefold subdivision of the Earth and current natural science subdivisions reveals the following (terms: Steiner underlined, natural science in **bold**, italicized introduced here):

- (1) FIRST VEIL: MINERAL = **surface rocks, soil, water** = *beauty*;
- (2) SECOND VEIL: BODY: World of Nature Spirits that produces the Forces of Nature = **solid lithosphere+plastic asthenosphere** = *wonder*: these use the etheric, natural, life forces to produce archetypal processes, such as weathering, crystallization, plate tectonics, metamorphism, and melting that produce the various stages in the rock cycle, e.g. magma, igneous, sedimentary and metamorphic rocks;
- (3) THIRD VEIL: SOUL: Spirits of the Rotation of Time, which orchestrate the Laws of Nature emanating from the astral, soul forces = **viscoelastic mesosphere** = *renewal*: this is created by additional archetypal processes (rhythmical mantle convection and plumes, and ring vortices that involve heat, radioactivity, and boson transfer);
- (4) SPIRIT: Planetary Spirit (Ego) from which arise the Meaning of Nature = **liquid and solid core** = *love*: wherein lie archetypal processes, such as gravity and magnetic energy fields involving the exchange of elementary particles, gravitons and photons, respectively - gravity drives convection, plate tectonics and holds the planet and its' atmosphere together, whereas magnetism provides a balance between earth and solar energy/radiation.

Lovelocks' Gaia hypothesis posits that the biosphere regulates the Earths' atmosphere, however with advent of the Anthropocene Era the balance is being upset by humans, who are rapidly changing the atmosphere, hydrosphere, biosphere and lithosphere producing massive extinctions – can humans curb this trend? This will require re-awakening knowledge and love of the Earth, the only living planet in our galaxy. Possible green solutions include primal energy sources, which include deep geothermal energy and artificial photosynthesis using cyanobacteria, the latter used as a natural fertilizer and food supplement.

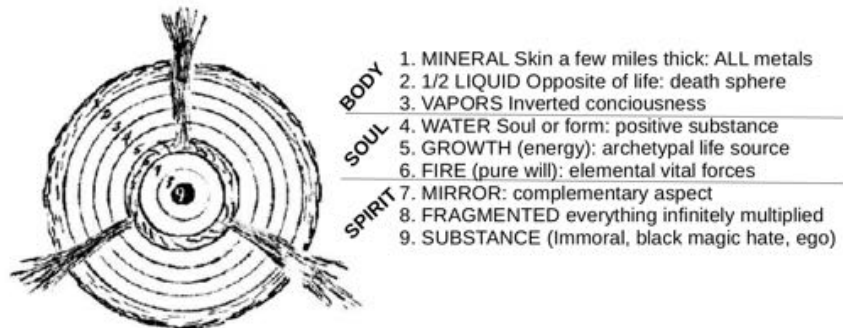
OBJECTIVE

The objective of this article is to take the natural scientific discoveries about the Earth over the past century into spiritual scientific research.

INTRODUCTION

This article first reviews knowledge of the earth over the last century using Rudolf Steiner's spiritual science approach and natural science, which formed the basis for a new spiritual view of Gaia, the living earth. By the beginning of the 20th century, drilling and mining had only penetrated the earth to a depth of a few thousand metres, so early concepts of the interior of the Earth were largely conjectural. Given the lack of natural scientific data, *Rudolf Steiner* (1905; 16th April 1906; 12 June 1906; 1907; 1912) used Spiritual Science combined with the idea that the Earth is a “living being” similar to the 3- and 9-fold human being, to conclude that the earth is made up of three layers (Body, Soul, and Spirit), each of which is sub-divisible into three more layers with various compositions and attributes (Fig. 1, Table 1, see appendix #1 for a more extensive summary).

FIGURE 1. Steiner's view of the interior of the Earth (*Steiner*, 1906).



EARTH Layers 1906	Composition 1906	Spiritual 1906		#Spiritual beings 1912	HUMAN being 1907		Human energy bodies 1905		
							Plane	Chakras	Auras
Mineral crust	Mineral skin		Physical	Skin	PHYSICAL	Material	PHYSICAL	Root	Etheric
Negative life	1/2 liquid	BODY	Etheric	NATURE	LIFE	Life		Spleen	Emotional
Inverted consciousness	Vapour		Astral	SPIRITS Earth, Fluid Air, Heat		Soul		Solar plexus	Mental
Circle of forms	Water	SOUL	Sentient	SPIRITS OF ROTATION OF TIME Rhythmic alternation	ASTRAL	Sentient	ASTRAL	Heart	Astral
Circle of growth	Energy		Mind			Mind			
Circle of fire	Warmth, heat		Conscious			Conscious			
Circle of decomposition	Mirror	SPIRIT	Self	PLANETARY SPIRIT Planetary and Cosmic environment	EGO	Human	SPIRITUAL	Throat	Etheric template
Circle of fragmentation	Fragments		Life			Life		3 rd Eye	Celestial
Egocentric	Moral Substance		Man			Divine		* Crown	Ketheric

Grey backgrounds represent the three veils of Steiner (1912)

*A common addition

Arrow points upwards

#In the absence of specific words in the language, Steiner (1912) used the word “spirit” for forces and/or energies.

TABLE 1. Summary of Steiner’s earth and human attributes by year.

The first quarter of the 20th century saw the advent of seismographs to record earthquakes as P- and S-waves, i.e. Primary and Secondary waves, which are compressional and shear waves, respectively (Oldham, 1906; Weichert and Geiger, 1910, and references therein; Gutenberg, 1913; and Jeffries, 1924). Although both P- and S-waves travel through solids, only P-waves travel through liquids, and this allowed identification of the liquid outer core (Fig. 2). Further development of seismology over the past century has allowed the Earth to be divided into Lithosphere + Asthenosphere (crust and upper mantle), Mesosphere (lower mantle), and Core (Fig. 2, see appendix #2 for a more extensive technical summary). With increasing depth and increasing temperature, the upper mantle changes from rigid to plastic, where it is partially melted and contains 1-3 times the amount of water in all of the world's oceans (Oskin, 2014), and forms a transition zone on which the lithosphere slides.

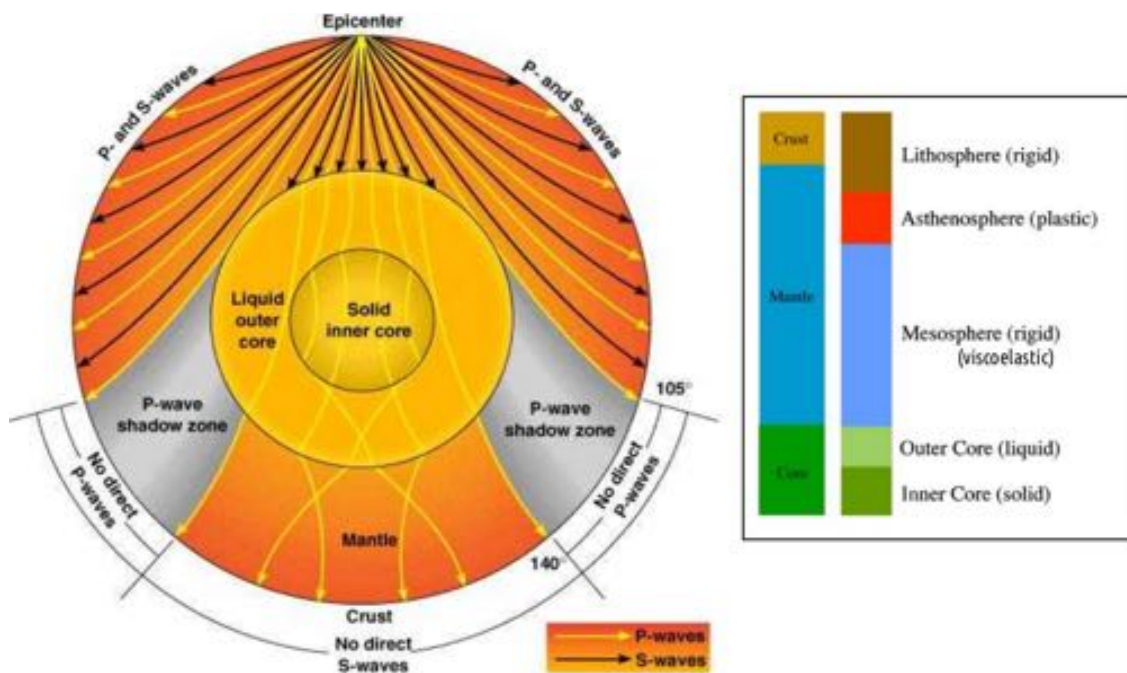


FIGURE 2. Interior of the Earth based on:

(a) seismology (after <http://www.artinaid.com/2013/04/earthquakes/>)

(b) composition and physical properties

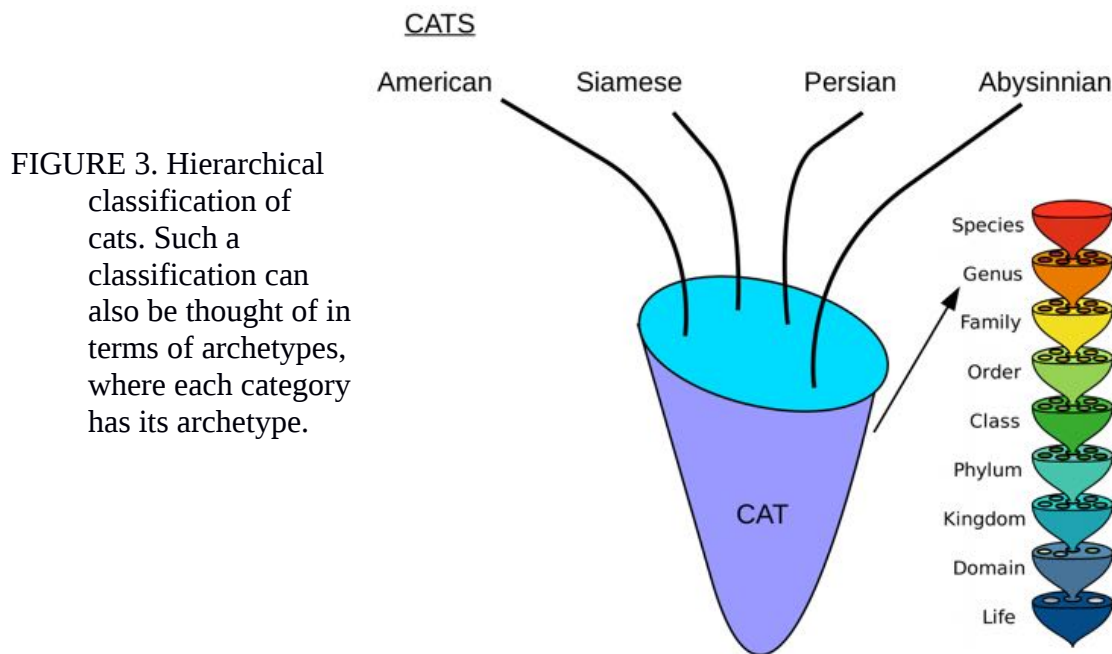
http://tvnight.com/geo/JohnVolos/Public/Portal/EARTH_MECHAN/structure_of_the_earth.htm

ARCHETYPES

Goethe (1995) was one of the first to study nature from a scientific perspective and recognized that the outward expression was merely the visible form of archetypal processes. As Goethe's scientific writings have been comprehensively reviewed by Steiner (1988, 1992), Ballivet (1995) and Ebach (2005), only a brief summary is provided here. Goethe applied a phenomenological approach to science involving intuitive perception or how the studied thing would describe itself if it had the ability to speak (Spiegelberg, 1982). Phenomenology is an active rather than passive involvement, i.e.

“nature naturing versus nature natured” or an evolving versus a static object, respectively, and involves a process Goethe called metamorphosis or transformation: in modern evolutionary developmental biology (evo-devo) this is dynamic topology, as distinct from static topology (Riegner, 2013). *Goethe* envisaged an archetype as the essential pattern or process of a thing (*Ur-Phänomen*), where *Ur-* bears the connotation of primordial, basic, elemental, archetypal; the ur-phenomenon may be thought of as the “deep-down phenomenon,” the essential core of a thing that makes it what it is and what it becomes.

Riegner (2013) further extended the archetypal idea to a hierarchical series of nested archetypes. One example given by Riegner (2013) is the archetypal triangle that is part of the higher order archetypal polygon, which includes archetypal rectangles, trapezoids, and hexagons. On the other hand, the archetypal right triangle is a lower order archetype below the archetypal triangle. Note that whereas an individual triangle is static and visible to the eye, the archetypal triangle is an essential pattern that underlies all triangles. Another example is the cat (Fig. 3) that is nested within the carnivore, which is, in turn, nested within the mammal. Again one individual cat is an object that can be seen by the eye, whereas the archetypal cat is the essential pattern that makes a cat, a cat, which fits within the higher category of carnivores.



However, any visible cat is but one instant in its life cycle, which is a dynamic process. In this article, the idea of nested archetypes is extended in the time dimension, which depicts the static categories, such as species, genus, family, etc. along one axis and time along the other axis where time is subdivided into eras, such as Cenozoic, Mesozoic and Paleozoic, the boundaries between which have been dated using geochronology (Fig. 4). The time element introduces the question: when did the primordial element or unit first appear? The first appearance of a unit is recorded by sensory discovery in the fossil record and is a static element. Note that the categories along both of these axes represent things determined by the senses and extensions of the senses, behind which lie the

Goethean archetypes. Imagination and intuition are required to envisage the life cycle of the first flowering plant or cat and what lies behind its' visible expressions. In Goethe's time knowledge of the fossil record and the time scale was in its infancy, so it is instructive to examine the plant archetype where Goethe most fully developed the archetypal concept.

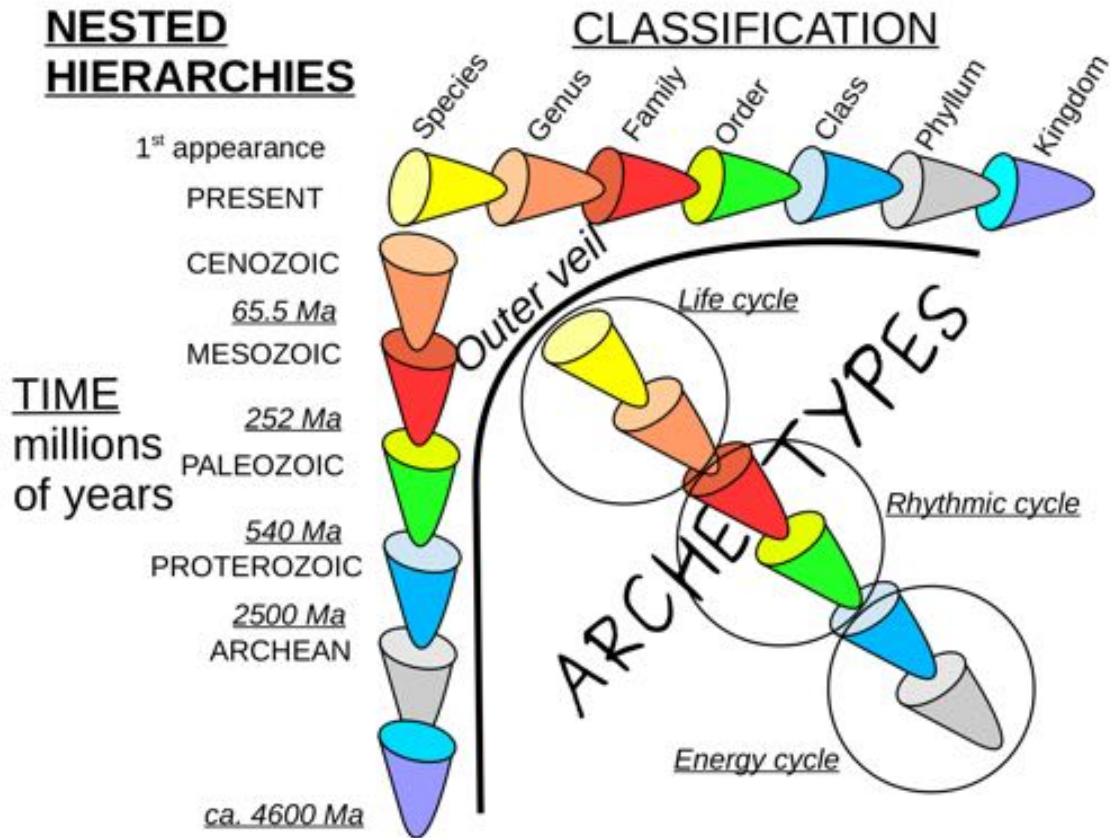


FIGURE 4. General plant and animal nested hierarchies: classification, time and archetypes.

Plant archetypes

Goethe (2009) most fully applied the archetypal idea to plants and identified the leaf as the dynamic archetype (Table 2, Fig. 5), which transforms from seed, through stem, leaf, flower, and stamen/pistil and back to seed again (the flowering plant life cycle in modern terms). According to *Goethe* this metamorphosis involves two driving forces: (i) intensification, a state of ever-striving ascent toward perfection and the fullest expression of the potential inherent in the underlying idea or Urphenomenon, which is brought about by the progressive “refinement of sap”, i.e. the ABCDE model in modern evo-devo biology driven by the inner spirit (*Dornelas and Dornelas*, 2005), and (ii) polarity, a directional principle expressed as a pulsating expansion and contraction as the plant grows (*Steiner*, 1992, *Dornelas and Dornelas*, 2005; *Goethe*, 2009). *Goethe* recognized that he could equally have chosen any of the other stages of transformation: seed, stem, flower, etc., when he wrote: “we might equally well say that a stamen is a

LEVEL	PLANTS	EARTH	TRANSFORMATIVE PROCESS: archetype	LAYER	MEANING
SURFACE <i>1ST VEIL</i> Sense-perceptible	Range of plants	Sedimentary Metamorphic Igneous	Weathering	Earth's surface	BEAUTY WONDER
OUTER <i>2ND VEIL</i>	<i>Leaf</i>	<i>Crystal</i>	Crystallization Metamorphism Solid-state diffusion Melting	LITHOSPHERE (Crust+ upper mantle) ASTHENOSPHERE (Partially melted upper mantle)	MOTION
MIDDLE <i>3RD VEIL</i> Rhythms	Water Air	Heat Radioactivity Boson exchange	Mantle convection Mantle plumes Ring vortices	MESOSPHERE (lower mantle)	RENEWAL
INNER Energies	Solar radiation: Heat, Light: <i>Photon exchange</i>	<i>Photon exchange</i> <i>Graviton exchange</i>	Geodynamo: Electromagnetism Gravity field	CORE: OUTER INNER	LOVE

Grey backgrounds represent the three veils

Arrows point upwards

Archetypal points in *italics*

Archetypal processes in **bold type**

TABLE 2. Comparison of the “veils” in plants and the Earth.

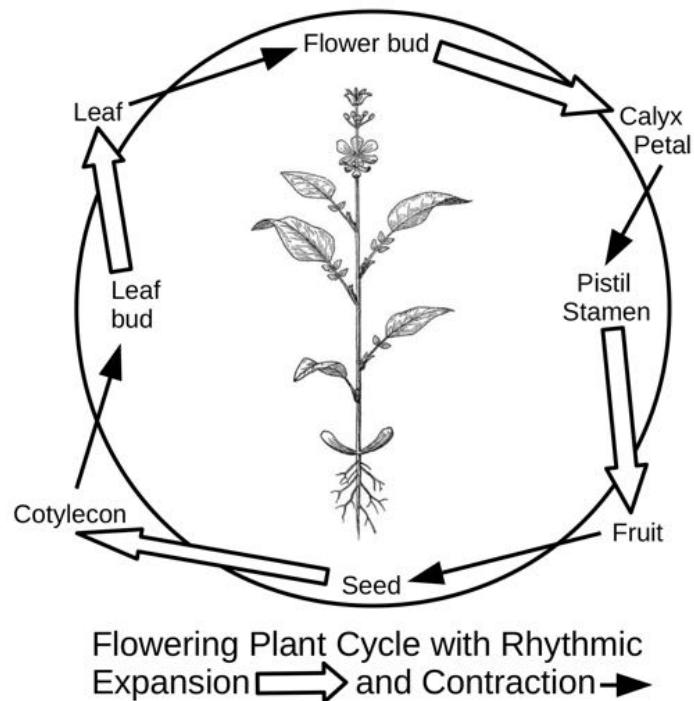
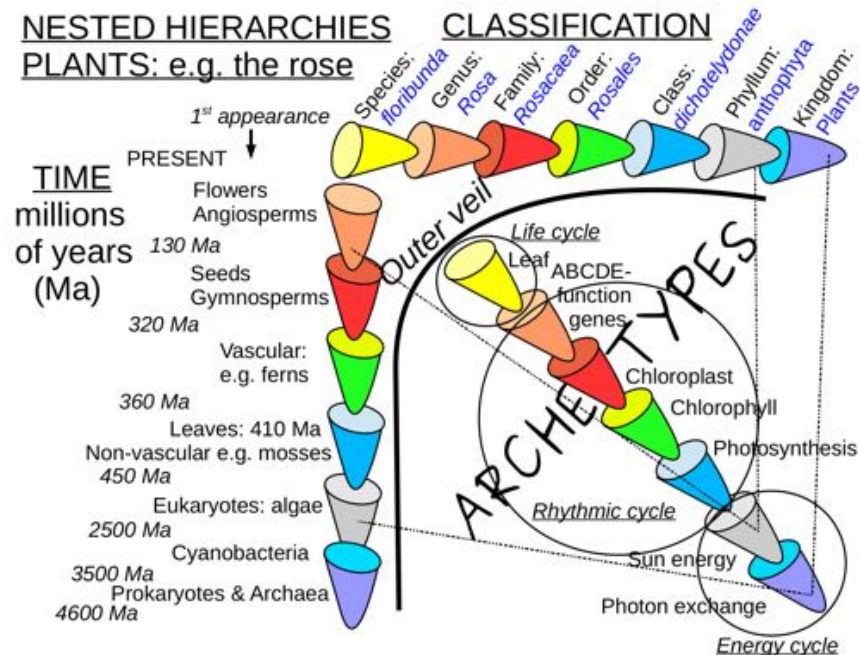


FIGURE 5. The life cycle of flowering plants showing directionality and pulsating expansion and contraction. Goethe’s archetypal plant is shown in the centre.

contracted petal, as that a petal is a stamen in a state of expansion; or that a sepal is a contracted stem leaf approaching a certain stage of refinement, as that a stem leaf is a sepal expanded by the influx of cruder saps” (Goethe, 1790, No. 120). However, Goethe (1790, No. 119) also wrote that “The organs of the vegetating and flowering plant, though seemingly dissimilar, all originate from a single organ, namely, the leaf”.

In this context, it is important to distinguish between the leaf as an object and the leaf as part of an archetypal process, in which the leaf is but one dynamic stage in transformation or in a cycle: the lack of such distinction leads to misunderstanding and a bias towards static topological classification over dynamic topological, evolutionary processes. Adding the prefix evo- is a potential way of identifying the archetypal process. Fluctuations of the archetypal leaf are generated by forces both outside and within the plant, and calls for a mutual adaptation of the plant and the environment. Thus, although the archetypal plant (evo-plant) is an idea that cannot be captured in a fixed way, Goethe (2009), realizing the importance of visual images for understanding, drew many pictures at various plant growth points and commissioned a number of watercolour paintings for a sequel to his book, *The Metamorphosis of Plants*. Goethe is reported as saying “we ought to talk less and draw more” (Gordon L. Miller in his Introduction to Goethe, 2009). With the advent of time-lapse photography and computers, a more complete record of the growth of an individual plant has been made possible (Li *et al.*, 2013), but again, it is important to understand that this records only fleeting static moments of one specimen with an interplay between internal and external forces. This interplay is succinctly summarized by Miller in his introduction to Goethe (2009) as *Proteus in potentia* (the basic nucleus of formative forces with its rich productive potential), *Proteus actus* (the actualization of this inner potential in a diverse range of organic forms), and *Proteus actus adaptatu* (actual physical structures and qualities, however, are affected by changing external conditions). In modern evo-devo biology, this interplay is expressed in the ABCDE model. The origin of plant and animal body plans remains largely unanswered (Gould, 2002): Goethe (2009) attributed this to the spirit.

FIGURE 6. Nested hierarchies of plants, e.g. the rose.



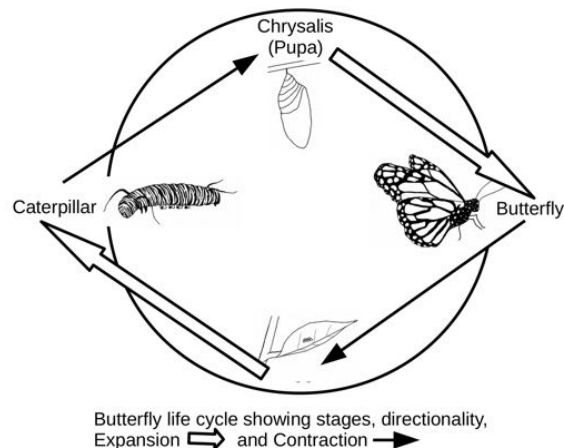
The oldest land plants are 450 million years old with the flower first appearing about 130 million years ago and the leaf ca. 410 million years ago in the Lower Devonian (Fig. 6)(Lawton-Rauh et al., 2000; Labandeira, 2007). So what are the life cycles of the oldest flowering and leafy plant, i.e. the archetypes? Can they be found in the living flowering plants or are these the products of inner forces and different environmental conditions? Answers to such questions require imagination and intuition: for Goethe answers involve the soul and spirit of the plant.

So what preceded leafy, land plants? About one to two billion years ago, these land plants were preceded by free-living, photosynthetic cyanobacteria that are thought to have entered early eukaryotic cells, in which some of the cyanobacterial genes were transferred to the nucleus of the host forming chloroplasts, where water and carbon dioxide are converted to sugars using the sun's energy (photons) and releasing oxygen in a process called photosynthesis (Nakayuma and Archibald, 2012). Cyanobacteria first appeared in the Archean, 3.2-3.5 billion years ago (Falcón et al., 2010), and are still alive today. Note that as there is a multitude of living cyanobacteria (Kashtan et al., 2014), each of which has a life cycle, behind which lies the ABC genetic model and the spirit of individual cyanobacterium. Thus, in a nested hierarchy, the cyanobacterium, chlorophyll and chloroplast are all archetypes in the sense that they represent stages in the life cycle (Table 2). The life cycle of living cyanobacteria may provide a general plan for the oldest cyanobacteria, but what provided the impulse for them to discover photosynthesis: their soul and spirit? Cyanobacteria are important as a natural fertilizer, as a health supplement, and have potential as a biofuel in a process that recycles carbon dioxide.

Animal archetypes

Goethe (1995) in working towards an archetype for animals posited the vertebrae as a potential archetype. Recent applications of the Goethean approach have been published by Schad (1977, 2012) and Riegner (1998, 2008) to mammals and birds, to which the interested reader is referred. The butterfly life cycle, an example of an animal life cycle, is depicted in Figure 7, and stages with the prefix “evo” could be called archetypes. An animal example of time is shown for cats in Figure 8. The oldest big cat fossils are 4-6 million years old (Tseng et al., 2013). So what can we intuit about the oldest big cats soul and spirit and environment? A still higher level would be an ideal organism that was primal to both plants and animals: such an organism appears to be the bacterium. It is uncertain whether the cyanobacteria originated on earth or were brought to earth on stony meteorites.

FIGURE 7. The life cycle of butterflies.



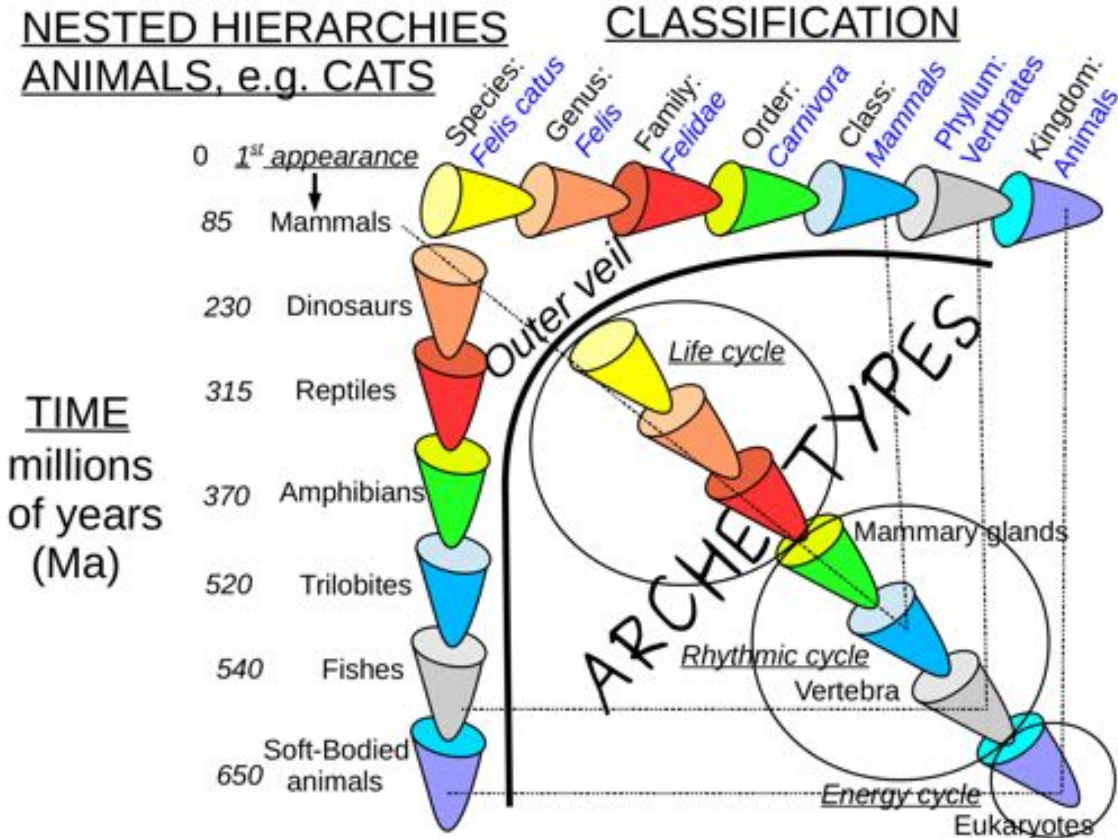


FIGURE 8. Nested hierarchies of animals, e.g. the cat.

THE EARTH'S VEILS

Steiner (1912) in applying the Goethe's archetypal idea to the Earth extended it to three layers that represent veils (Table 1), where the outer veil is the physical world that is available to the senses: eyes, touch, ears, etc. Behind this veil lie the Nature Spirits, which *Steiner* (1912) describes as earth (physical form), fluid (metamorphosis/transformation), air (light) and heat (warmth). These Nature Spirits constitute the second veil, behind which lie the Spirits of Rotation of Time that organize the rhythmic alternation and repetition of happenings in time. The Spirits of Rotation of Time form the third veil, behind which lies the Planetary Spirit that places the earth in the cosmos. Each of these hidden layers may be sensed on the earth's surface as the Forces of Nature, Laws of Nature and Meaning of Nature, respectively (*Steiner*, 1912).

1. Below the FIRST veil (the earth's surface) lies the Lithosphere and Asthenosphere (see appendix #2 for a more comprehensive summary)

The surface of the Earth is covered by either rock or soil derived from rock by the interaction of factors such as climate, topography, organisms and time. Goethe posited that the archetype for all rocks might be granite because he believed granite underlay everything and was the oldest rock crystallizing out of a primal liquid (*Kuhn*, 2009). However, *Steiner* (1988) says:

"Goethe, in fact, never maintained that granite actually passes over into something different. What is once granite is a finished, complete product and no longer has the inner

driving power to become something else out of itself. What Goethe was seeking, however..... is the idea, the principle that constitutes granite before it has become granite, and this idea is the same one that also underlies all other formations. When Goethe speaks therefore of the transition of one rock into a different one he does not mean by this a factual transformation but rather a development of the objective idea that takes shape in the individual forms, that now holds fast to one form and becomes granite, and then again develops another possibility out of itself and becomes slate, etc.”

Now let us first look at the statement: granite is a finished, complete product and no longer has the inner driving power to become something else out of itself. *Ballivet* (1995) in synthesizing Goethe's geological work, says that he recognized three categories of rocks: granite, stratified rock and transitional rock: nowadays these categories are called igneous, sedimentary and metamorphic, respectively (Fig. 9). Furthermore, Goethe identified granite and stratified rock as polarities, which were **not** regarded as successive in time (*Ballivet*, 1995). Placing these rock categories in the modern rock cycle, which here includes molten rock (magma), shows that all four have polarities involving alternating, directional contraction and expansion, i.e. a 1st-order polarity (Fig. 9). Thus, granite is a type of igneous rock that constitutes a stage in the rock cycle (Fig. 9). Given the short life span of the human being (<120 years) compared with the millions of years involved in geological processes, it is understandable that Goethe would believe granite to be a final product rather than one stage in the rock cycle. On the classification versus time graph, granite is but one of a range of plutonic igneous rocks that originated early in the history of the Earth (Fig. 10).

On this 1st-order polarity is superimposed a 2nd-order polarity of expansion and contraction (Fig. 9). As magmas cool, minerals crystallize either continuously by gradual substitution of elements or discontinuously as different minerals forming over a limited temperature range (*Bowen*, 1956). The discontinuous series gives rise to a pulsating decrease in volume as each mineral crystallizes (Fig. 9). Sedimentary rocks are mostly derived from igneous, metamorphic and other sedimentary rocks by processes involving physical and chemical weathering and erosion by water, sea, ice and wind, which awaken the stored potential of the mineral to transform into other minerals. The products of weathering are mainly clay (crystalline sheets of hydrous aluminium phyllosilicates), and oxides (quartz, haematite, goethite), which mainly involves the hydration of minerals to produce a pulsating volume increase in the same sequence as in crystallization from magma, i.e. olivine to quartz (Fig. 9). The clay and oxide minerals are deposited as clastic rocks, such as sandstone and shale. Oceans also contribute to deposition when: (i) calcium combines with carbon dioxide to produce limestone, which are also formed by accumulation of skeletal remains of living organisms, and (ii) evaporation of seawater to produce evaporites, such as salt and gypsum. Metamorphic rocks form by transforming both sedimentary and igneous rocks with increasing the heat (temperature) and/or pressure without melting (Fig. 9). Progressive metamorphism involves a pulsating volume decrease as individual mineral species crystallize over different temperature and pressure ranges (Fig. 9). Injection of magma causes the temperature to rise in the adjacent rocks, producing contact metamorphic rocks called hornfels. Increasing both the temperature and pressure induces solid-state diffusion, an archetypal process, which generally begins at half the melting point of the mineral on the Kelvin scale. The transformation may involve a phase change where the crystal structure changes without a

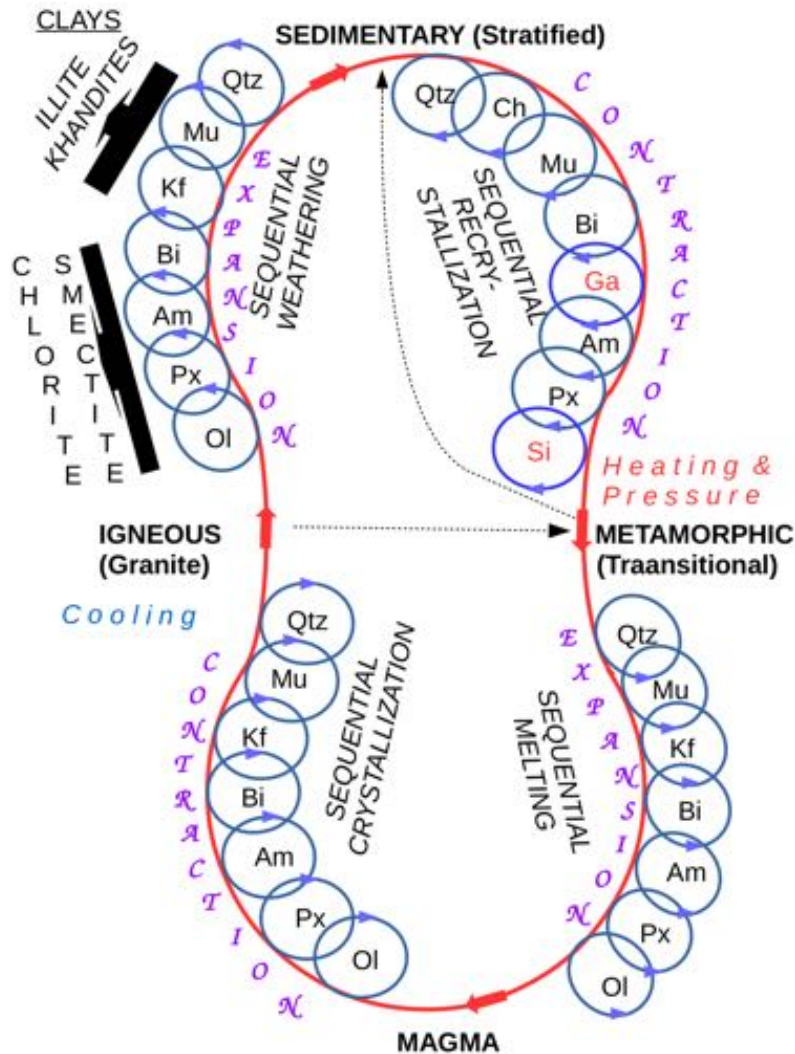


FIGURE 9.

Rock cycle showing 1st- and 2nd-order stages with directionality (red and blue arrows) and pulsating volume change in the shape. The 1st-order stages rotate through cooling from magma through igneous to sedimentary (red outline), and heating/pressure from sedimentary through metamorphic to magma, and involve alternating expansion and contraction (Goethean terms are in parentheses). 2nd-order stages show sequential crystallization of different igneous minerals from the magma, sequential weathering of different igneous mineral to clays, sequential recrystallization to metamorphic minerals, and sequential melting of different minerals: individual mineral growth is illustrated as clockwise or anticlockwise blue circles within or outside the main cycle (red) depending on whether the process involves expansion or contraction. Note the symmetry in contraction and expansion, and the appearance of different minerals (common rocks are illustrated – carbonates involve different minerals not illustrated here). Dotted lines indicate shortcuts in the cycle. Note that quartz survives throughout the 1st-order cycle. Ol = olivine, Px = pyroxene, Am = amphibole, Bi = biotite, Kf = potassium feldspar, Mu = muscovite, Qtz = quartz, Ga = garnet, Si = sillimanite.

compositional change. On the other hand, neocrystallization is the creation of new minerals by chemical reactions involving very slow, solid-state diffusion. If there is a differential pressure, the new minerals align themselves producing a cleavage (slate) or a foliation (gneiss). The pressure-temperature space has been divided into metamorphic facies using co-existing, key minerals that transform with changing temperature and pressure to produce metamorphic facies series (Table 2). At higher temperatures metamorphic rocks begin to melt, thereby returning to the igneous rocks in the rock cycle (Fig. 9).

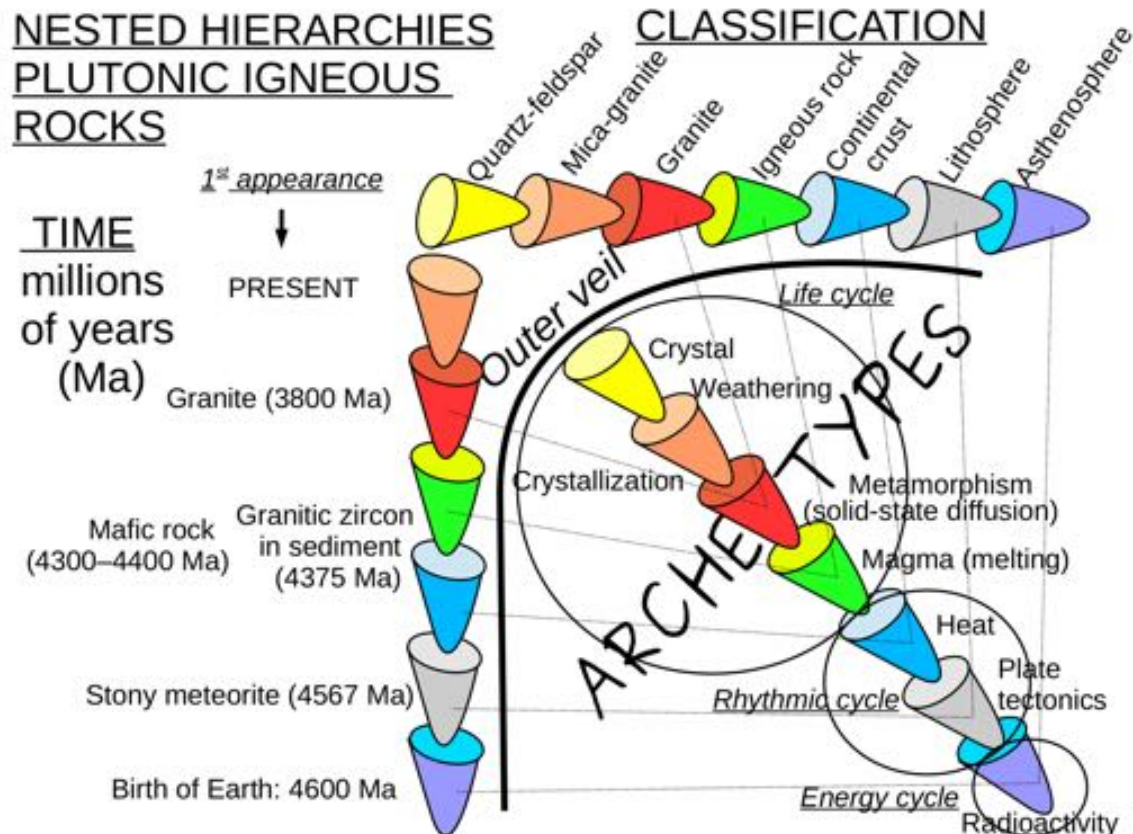


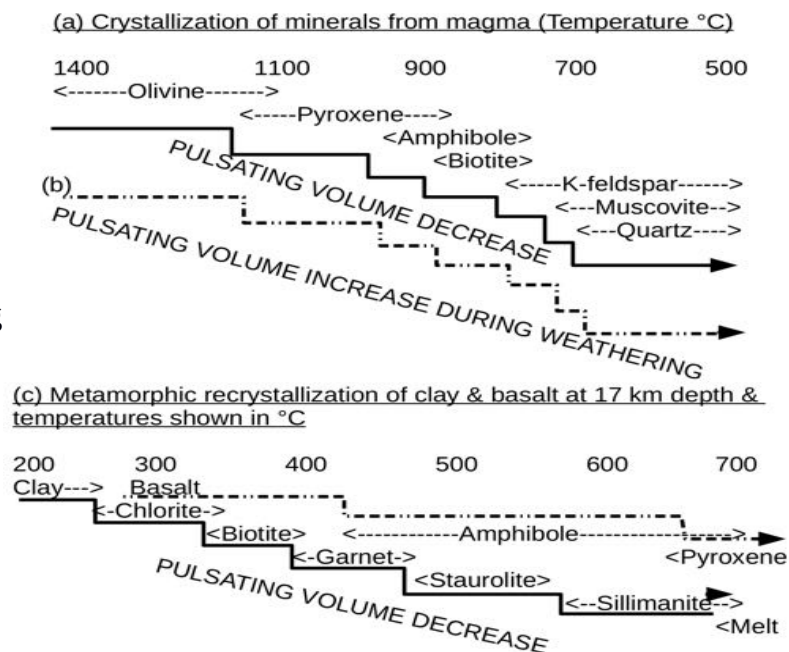
FIGURE 10. Nested hierarchies of plutonic igneous rocks.

In the light of modern earth science, let us now see if granite is the oldest rock underlying everything and crystallizing out of a primal liquid. The oldest rocks on earth are stony meteorites (chondrites) composed mainly of silicate minerals: pyroxene, olivine and plagioclase, and metallic Fe-Ni and sulphides (Fig. 10). Although chondrites have a composition similar to the bulk earth, which is mainly O, Mg, Si and Fe (Javoy et al., 2010), recent work has shown that the early mantle, now located near the mantle/core boundary, had 60-70% less K, U, and Th, and a superchondritic Nd and Hf isotopic composition (Boyet and Carlson, 2006). The oldest stony meteorites have been dated as ca. 4.567 billion years old, about the same age as the age of the earth and our solar system (Amelin and Krot, 2007). The oldest, dated granites are ca. 3.8 billion years old (Condie, 2010), however, the oldest, granite-derived, dated zircon in sedimentary rocks is

4.375 billion years old (Valley *et al.*, 2014). The oldest, dated mafic-ultramafic rocks are ca. 4.3-4.4 billion years old (Condie, 2010), which overlaps the time of the oldest granite. As the oldest granites originated by separation (fractionation) from mafic magma, they formed at the same time. Over time, separation of granite accumulated to form the continents, so Goethe's supposition that granite underlay everything was in accord with his experience on land. However, it is now known that felsic continental crust is underlain by a basaltic layer (composed of pyroxene and plagioclase) and forms oceanic crust, which in turn, overlies the upper mantle composed mainly of peridotite (an ultramafic layer composed of olivine and pyroxene) (Pidwirny, 2013). Thus, as superchondrites are the same composition as the Earth as a whole, they probably represent the primal liquid from which crystallized the solid surface of the earth. The amalgamation of stony meteorites to form the Earth would have led to melting.

By analogy with the leaf as a plant archetype, what is the essential pattern in rocks? Crystal grains, either pristine or abraded, are common to all rock types except amorphous mineraloids, such as volcanic glass and opal, which become crystalline over time. The most common crystals are silicates, which have a vast range of forms that have been arranged in families (e.g. pyroxene, amphibole, mica, feldspar) that display continuous ranges of composition. Quartz crystals are resistant to chemical weathering and are abraded by water, wind and ice ending up as abraded quartz in sedimentary rocks. Clay crystals form by weathering, whereas metamorphic crystals form by growing within rocks undergoing increasing temperature and pressure. There are many fundamental crystal forms that can transform into other forms through weathering, metamorphism and melting, all of which constitute archetypal processes (Figs. 9 and 10; Tables 2 and 3). Thus, crystals may be likened to the leaf as an archetype in the evolutionary process of crystallization.

TABLE 3. Pulsating volume changes involved in: (a) crystallization of igneous rocks from a magma; (b) weathering of various minerals; and (c) metamorphic recrystallization of clay and basalt.



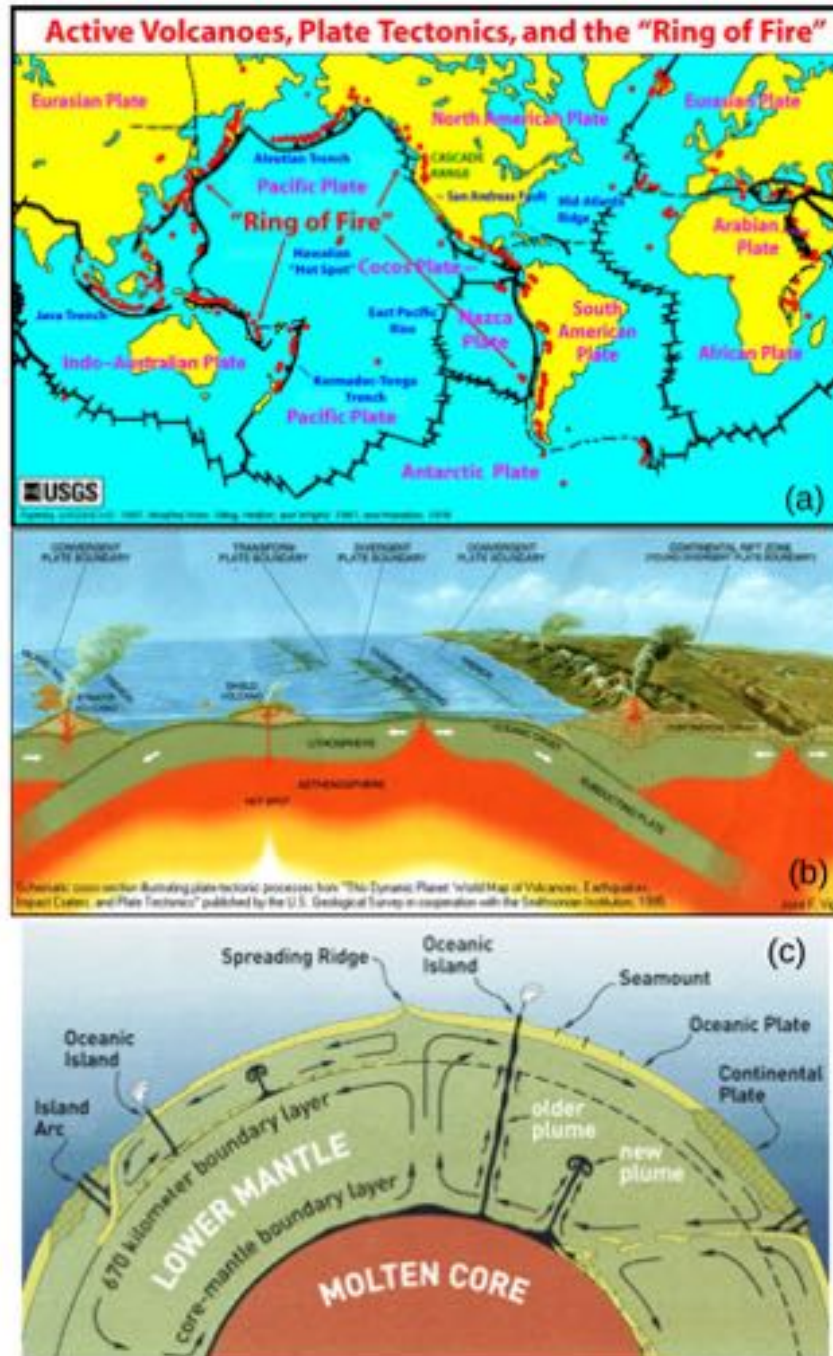


FIGURE 11.

Plate tectonics and volcanoes: (a) map (USGS, 1997); and (b) cross-section (USGS, 1995); (c) Cross section of the Earth showing surface plates, upper and lower mantle, outer core, boundary layers at 670 (upper-lower mantle) and 2900 km (core-mantle) kilometers, and several postulated locations for mantle plumes. The left side shows two-layer convection while the right side portrays whole-mantle convection (courtesy Stan Hart) after <http://www.whoi.edu/NobleMetals/Fproject2.htm>.

The generation of magma by the melting process is closely linked to plate tectonics, an archetypal process (Fig. 11): (i) rifting thins the lithosphere causing the mantle to rise and the resulting decrease in pressure induces melting; (ii) subduction of the lithosphere into the mantle introduces heat into the lithosphere causing it to melt, which produces igneous activity above the subducting plate, e.g. the “Ring of Fire” around the Pacific Ocean; and (iii) magma plumes rising from depth – more fully discussed below.

The lithosphere was called the World of Nature Spirits by *Steiner* (1912), which consists of several classes/elements: solid/earth, fluid/water, vapour/air and heat/fire. These classes of Nature-Spirits produce the Forces of Nature, which can be related to the processes operating between igneous, sedimentary and metamorphic rocks (Fig. 9). These nature forces are the archetypes. The lithosphere provides the solid foundation for most plants and animals, and provides the basis for life on Earth, such as agriculture, food, etc. (Table 2). The Earth's surface is a place of **beauty** leading to wonder of the intricate relationships in nature.

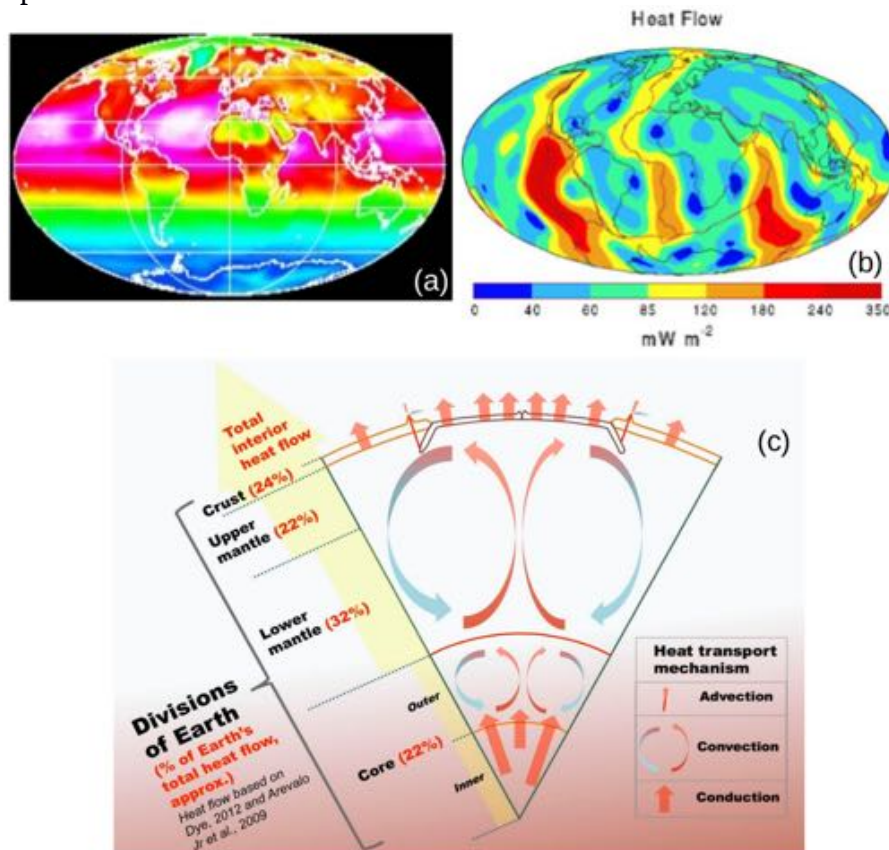


FIGURE 12.

(a) Average Net Radiation at the Earth's Surface: July 1983-1990 (Pidwirny, 2013); (b) Heat flow on the earth's surface is highest over the mid-oceanic ridges (KamLAND, 2006, 2011); and (c) Main contributions to Earth's total internal heat flow to the surface, and the dominant heat transport mechanisms within the Earth (Bkilli, 2013: https://en.wikipedia.org/wiki/Earth's_internal_heat_budget#/media/File:Heat_flow_of_the_inner_earth.jpg) based on Dye, 2012, Arevalo et al., 2009.

2. Below the SECOND veil lies the Mesosphere (Fig. 2)(see appendix #3 for a summary of the forces, fields, energy, and elementary particles)

Although the Mesosphere (lower mantle) appears to be solid because it transmits both P- and S-shear earthquake waves, it is probably viscoelastic because, over a long time period, convection cells appear to operate (Figs. 2 and 11c)(*Ogawa*, 2008), which, along with conduction, aid in cooling the Earth (Fig. 11c). Temperatures at the surface of the Earth are predominantly produced by the sun's radiation, with a minor contribution from within the Earth (Fig. 12). Heat generation by radioactive decay facilitated by boson exchange represent archetypes, and occurs throughout the earth (Fig. 12c). Cooling of the Earth is also facilitated by mantle plumes, which originate in "plate graveyards", i.e. accumulation of subducted lithosphere, at depths of ca. 650 km and at the Mantle-Core boundary (Fig. 11c). Some mantle plumes rise to the surface producing volcanic chains (e.g. Hawaii: Figs. 11b and c), and ideal mantle plumes have a mushroom-shape produced by a ring vortex. The rising mantle plumes are counterbalanced by down-going currents producing an upside-down mushroom (Fig. 13). Convection, mantle plumes and ring vortices all represent archetypal processes (Table 2).

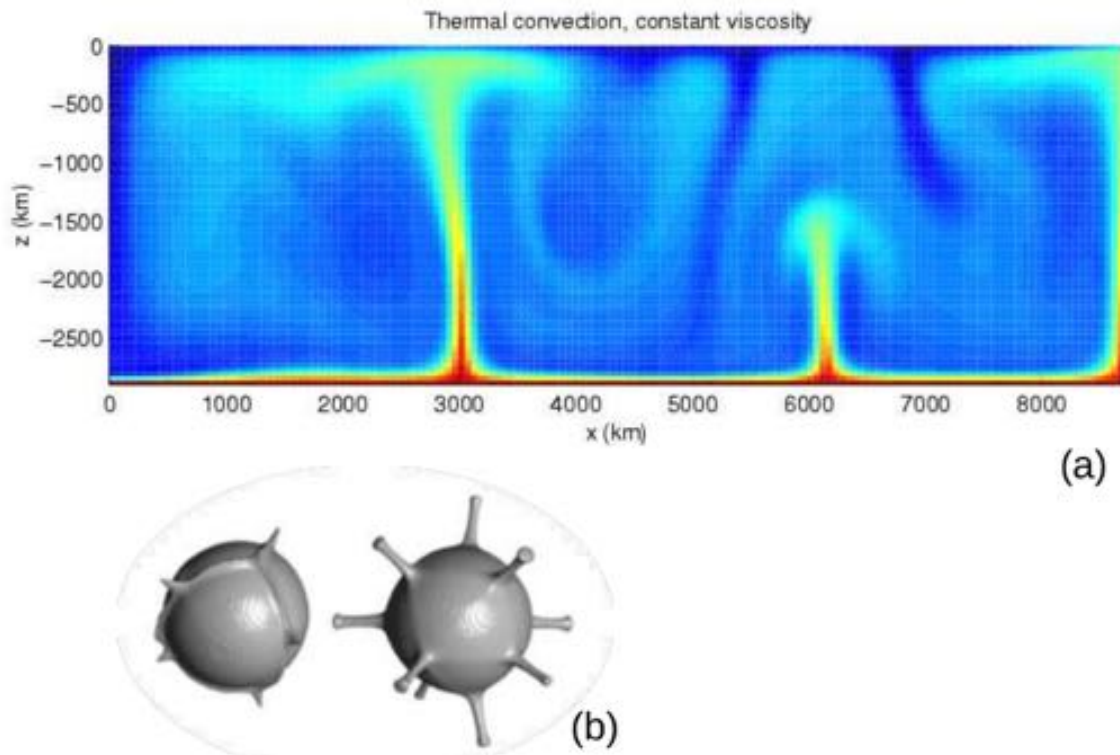


FIGURE 13. Mantle dynamics: (a) in 2-dimensions (after <http://user.uni-frankfurt.de/~schmelin/what-is-convection.html#Englishversion>); and (b) mantle plumes rising from the mantle/core boundary in 3-dimensions (after Futterer et al., 2013).

The Earth's Mesosphere is the astral domain of Steiner's Spirits of the Rotation of Time (Steiner, 1912), which give rise to the Laws of Nature. Examples of such laws provided by *Steiner* (1912) are the rhythmic rotations of night and day, and the seasons. Over the past century, several other laws have been identified, such as Milankovich cycles (*Milankovitch*, 1941), which are a combination of precession (rotation of the Earth's axis every 26,000 years), the rotation of the elliptical orbit (the combined effect with precession leads to a 21,000-year period between astronomical periods), obliquity (oscillation in the angle between the Earth's axis on a 41,000-year cycle) and solar forcing. The rhythmical overturn within the Mesosphere, convection and plumes, provide regular renewal of the lithosphere, a process that may be likened to metabolism in humans.

3. Below the THIRD veil lies the Core (Fig. 2)(see appendix #3 for a summary of the forces, fields, energy, and elementary particles)

The Core of the Earth lies beneath the Mesosphere. Although the outer and inner core have similar, Nickel-Iron compositions, the inner core is solid whereas the outer core is liquid: this is based on whether earthquake shear waves are transmitted or not, respectively (Fig. 2). Imagination and intuition has led to the idea that convection cells in the outer core produces a geodynamo, from which the earth's magnetic field emanates (Fig. 14a). The geodynamo produces the ionosphere and magnetosphere (Figs. 14b and c), both of which protect organisms living on the Earth's surface from cosmic and solar radiation, including x-rays and UV radiation. The inner core of the earth is the centre of the Earth's mass, which produces gravity that holds the earth and it's atmosphere together as well as controlling plate tectonics. The geodynamo, gravity and magnetic energy fields form archetypal processes in the core. The magnetic and gravity fields involve the exchange of protons and gravitons, which maybe considered as archetypes involving the soul and spirit of the Earth, which may also be depicted as a series of nested archetypal hierarchies (Fig. 15, Table 2).

Oxygen, hydrogen and carbon in the atmosphere are released from minerals in the earth by chemical reactions producing O₂, H₂O and CO₂ in the air we breathe and the water we drink, thereby providing some of the conditions for life on earth. Furthermore, ozone produced by the interaction between ultraviolet radiation and oxygen provides a further protection for life on earth. The balance between extra-terrestrial and terrestrial fields is one of the factors that provides an environment for life, and humans are increasingly capable of altering this balance. Other factors may include a galactic and circumstellar habitable zone, a terrestrial planet of the right size with a magnetosphere and plate tectonics (*Ward and Brownlee*, 2000).

The four fundamental forces, gravity, electromagnetic, strong and weak nuclear, all involve the exchange of particles (Appendix #3), which, using Steiner's language, could be considered as elemental beings. These particles originated during early inflation, which could be similarly envisaged as the "Christ Impulse". The Earth's Core was called the Planetary Spirit by *Steiner* (1912), which brings the earth into mutual relation with other bodies in the cosmos and gives Meaning to Nature. What is this meaning? The Earth's Gravity and Magnetic fields embrace the Earth as an expression of the LOVE that the Living Earth has for all living things on Earth.

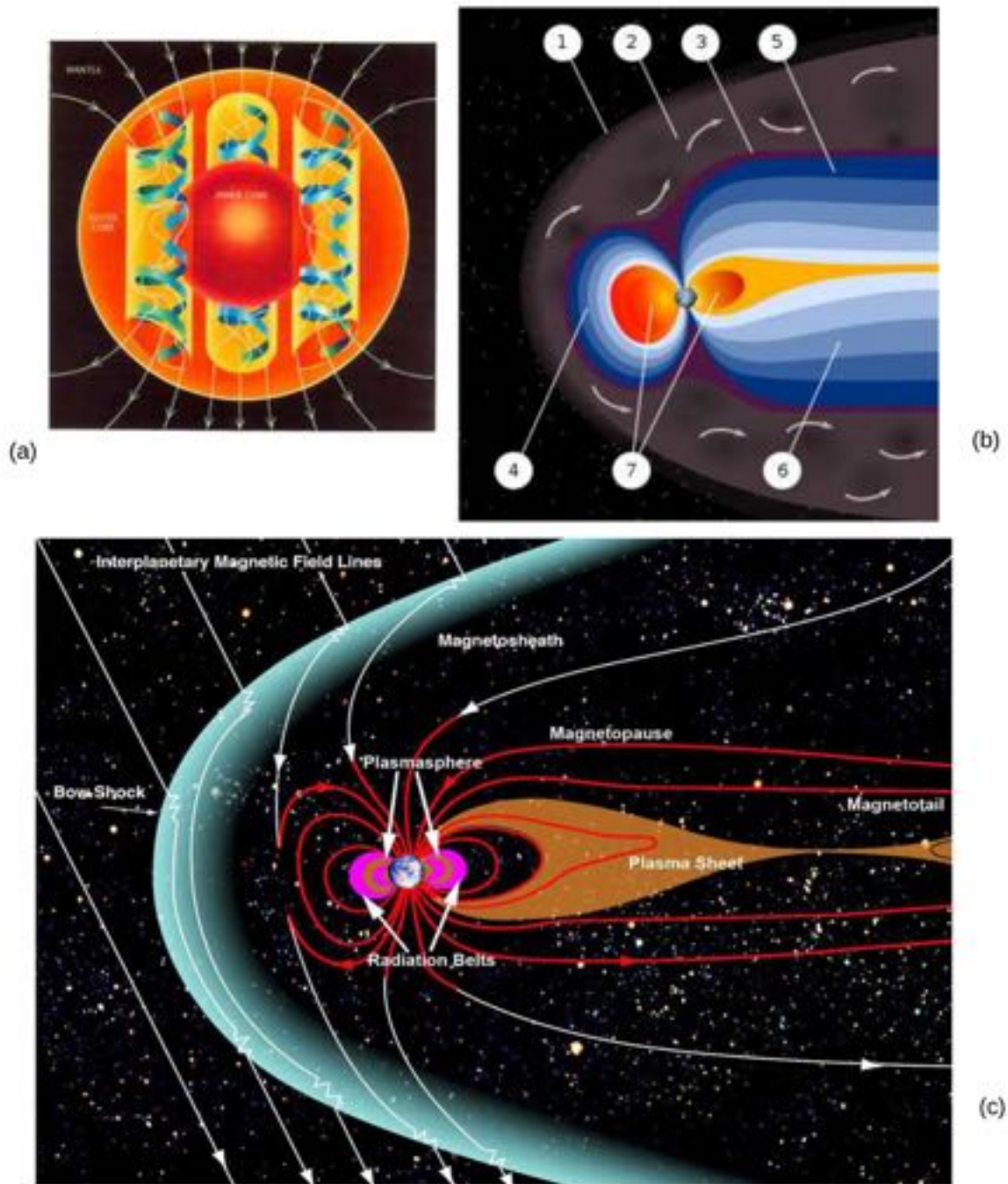


FIGURE 14. (a) Earth geodynamo generates a magnetic field (USGS, 2013) that produces a magnetosphere which deflects solar radiation and cosmic rays; (b) 1 = Bow shock. 2 = Magnetosheath. 3 = Magnetopause. 4 = Magnetosphere. 5 = Northern tail lobe. 6 = Southern tail lobe. 7 = Plasmasphere (Frédéric MICHEL – Magnetosphere_Levels.jpg; http://en.wikipedia.org/wiki/Magnetosphere#mediaviewer/File:Magnetosphere_Levels.svg); (c): Roberts Artal, 2013 and NASA - <http://astrobob.areavoices.com/tag/earth/>).

NESTED HIERARCHIES OF THE EARTH

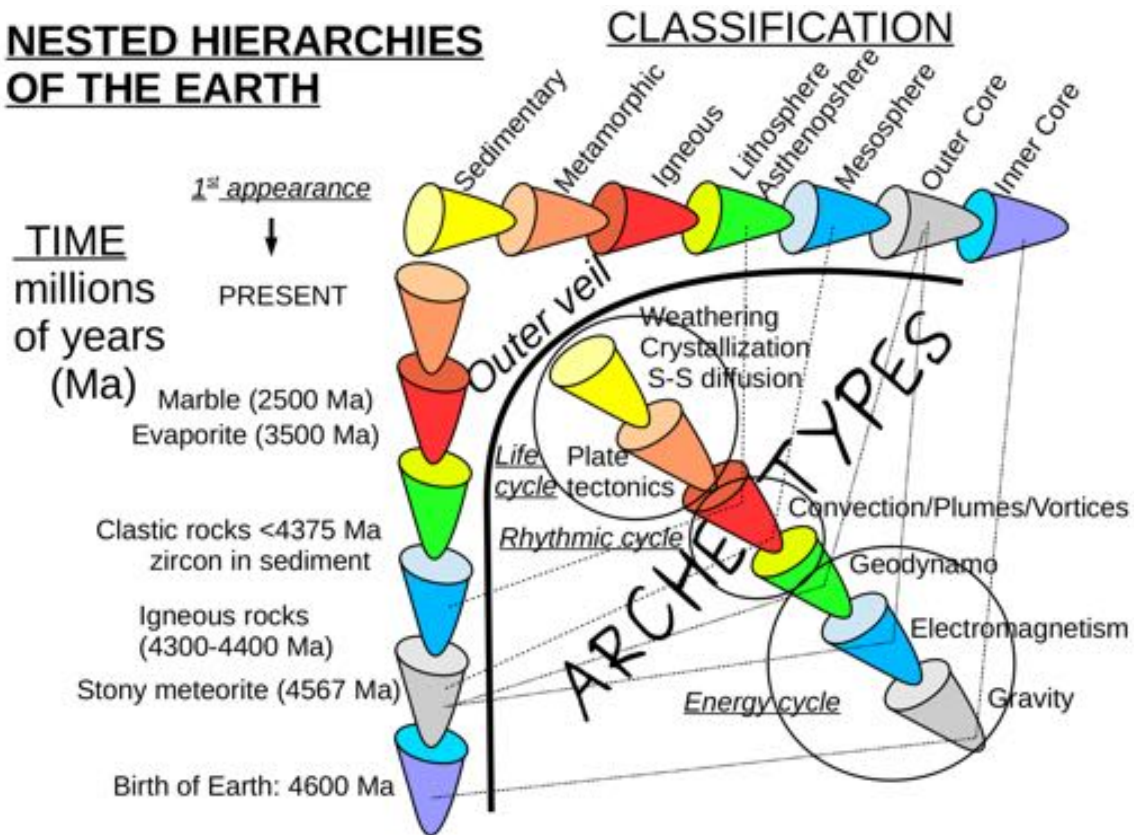


FIGURE 15. Nested hierarchies of the Earth.

GAIA

The thoughts provided in this article suggest that the earth is alive (c.f. *Hutton*, 1785 and *Lovelock*, 1972). The Gaia hypothesis was defined by *Lovelock* (1972) as "...a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system, which seeks an optimal physical and chemical environment for life on this planet". *Lovelock* (1979) gave a general, physical characteristic of life as a reduction of entropy, i.e. an increase in order. Biological definitions of life generally include homeostasis, organisation, metabolism, growth, adaptation, response to stimuli, and reproduction: all of these characteristics are present in the earth. This article extends the Gaia hypothesis to the whole earth by applying spiritual science to modern earth science discoveries. This expanded definition of Gaia compounds the difficulties in separating organic, animate life from inorganic, non-living matter: this difficulty was first expounded by Wöhler (1828), who synthesized "organic" urea from "inorganic" ammonium cyanate suggesting that a vital force is present in both inorganic and organic.

IMPLICATIONS

Human beings are increasingly impacting the earth's living environment, e.g. creation of the ozone hole, global warming, acid rain, urbanization, agriculture and a mass extinction (*Myers and Knoll*, 2001), all of which have been produced by human

activity. This has recently led to identification of the Anthropogenic Epoch, the onset of which has been related to extensive early farming and the collision of the New and Old World leading to homogenization of earlier distinct biotas that is coincident with a clear 1610 dip in atmospheric carbon dioxide (*Lewis and Maslin*, 2015). Furthermore, increasing human use of hydrocarbons over the past several centuries that typically took millions of years to form (the youngest is 5000 years old, oldest are 650 million years old), has led to global warming, acidification of the atmosphere, and massive extinctions. Agriculture generally uses the soil, which is produced by weathering: in tropical areas soil can form from bedrock in several years, whereas in desert areas it can take millions of years. The glacial soils of southern Canada are younger than 10,000 years, the age of retreat of the last glaciation. As it generally takes decades to several thousand years for a soil to develop a profile, are we taking care of the earth's soils is essential for plant and animal life? The overall question is: can we modify our behaviour to maintain the Earth's protective embrace?

APPLICATIONS

In order to appreciate the difference between static and active natural science, the reader is encouraged to choose an object, investigate its life cycle, its first appearance, and the questions of what is hidden behind the “veils”. If one applies the axiom “The Present is the key to the Past”, one need only look at present processes to determine past life cycles. However, this does not take into account such things as catastrophes, e.g. (a) impacts of meteorites with the earth, and (b) that the earth is moving forwards in its’ life cycle through stages that are not presently evident on earth but may be observed on other planets, e.g. an early anoxic atmosphere.

Acknowledgements

I would like to thank Maggie Keppie for introducing me to anthroposophy, for bringing much relevant literature to my attention, and for reading the draft manuscript. I would also like to thank Jennifer Greene for accepting me into the North American Natural Science Section of the Anthroposophical Society in North America, for sharing her work on water that led to comparisons of processes in water and rocks, and for reviewing the paper. I am grateful to the organisers of the conference, Encountering our Humanity, held in Ottawa during 2016 for inviting me to present this work and arranging for publication because it benefitted from subsequent discussions. I am especially grateful to Eric Philips-Oxford who edited the English version and translated the manuscript into French.

References

- Amelin, Y., and Krot, A. 2007. Pb isotopic age of the Allende chondrules. *Meteoritics & Planetary Science* 42 (7/8): 1043–1463.
- Arevalo Jr, R., McDonough, W. F., and Luong, M. (2009). The K/U ratio of the silicate Earth: Insights into mantle composition, structure and thermal evolution. *Earth and Planetary Science Letters*, 278(3), 361–369.
- Ballivet, C. 1995. An overview of Goethe's geological writings. Archetype, Science Group, Anthroposophical Society in Great Britain, p.38-55.
- Bowen, N.L. 1956. *The Evolution of the Igneous Rocks*. Canada: Dover. pp. 60–62.

- Boyet, M., and Carlson, R.W. 2006. A new geochemical model for the Earth's mantle inferred from ^{146}Sm – ^{142}Nd systematics. *Earth and Planetary Science Letters* 250: 254 – 268.
- Condie, K.C. 2010. *Earth as an evolving planetary system*. Academic Press, 430 p.
- Dornelas, M.J., and Dornelas, O. 2005. *Brazilian Journal of Plant Physiology*, v. 17/4, p. 335-343.
- Dye, S. T. 2012. Geoneutrinos and the radioactive power of the Earth. *Reviews of Geophysics*, 50(3).
- Ebach, M.C. 2005. Anschauung and the Archetype: The Role of Goethe's Delicate Empiricism in Comparative Biology. *Janus Head*, 8(1), p. 254-270.
- Falcón, L., Magallón, S., and Castillo, A. 2010. Dating the cyanobacterial ancestor of the chloroplast. *The ISME Journal*, v. 4, p. 777–783.
- Futterer, B., Krebs, A., Plesa, A.-C., Zaussinger, F., Hollerbach, R., Breuer, D., and Egbers, C. 2013. Sheet-like and plume-like thermal flow in a spherical convection experiment performed under microgravity. *Journal of Fluid Mechanics*, v. 735, p. 647-683, Cambridge University Press, doi: 10.1017/jfm.2013.507.
- Goethe, J.W. von. 1778. On granite. *HA* 13, p. 258-303.
- Goethe, J.W. von. 1790. *Versuch die Metamorphose der Pflanzen zu erklären*. Gotha, Ettlenger.
- Goethe, J.W. von. 1995. *Scientific studies*. (D. Miller, Ed. & Trans.). New Jersey: Princeton University Press.
- Goethe, J.W. von. 2009. *The metamorphosis of plants*. MIT Press, 156 p.
- Gould, S.J. 2002. *The Structure of Evolutionary Theory*. Belknap Press, Cambridge.
- Gutenberg, B., 1913. Über die Konstitution des Erdinnern, erschlossen aus Erdbebenbeobachtungen. *Phys. Zeitschr.* 14, 1217–1218.
- Hutton, J. 1785. Abstract of a dissertation read in the Royal Society of Edinburgh, upon the seventh of March, and fourth of April, MDCCLXXXV, Concerning the System of the Earth, Its Duration, and Stability. Edinburgh. 30 p.
- Javoy, M, and 10 others. 2010. The chemical composition of the Earth: Enstatite chondrite models. *Earth and Planetary Science Letters*, v. 293, p. 259–268
- Jeffries, H. 1924. *The Earth, Its Origin, History and Physical Constitution*, Cambridge University Press. 278 p.
- Kashtan, N and 12 others. 2014. Single-Cell Genomics Reveals Hundreds of Coexisting Subpopulations in Wild *Prochlorococcus*. *Science*, v. 344 (6182), p. 416-420, DOI: 10.1126/science.1248575.
- Kuhn, B. 2009. *Autobiography and Natural Science in the Age of Romanticism: Rousseau, Goethe, Thoreau*. Ashgate Publishing.
- Labandeira, C. 2007. The origin of herbivory on land: initial patterns of plant tissue consumption by arthropods. *Insect Science*, v. 14, p. 259-275.
- Lawton-Rauh A., Alvarez-Buylla, E.R., and Purugganan, M.D. 2000. "Molecular evolution of flower development". *Trends in Ecology and Evolution*. v. 15 (4), p. 144–149. doi:10.1016/S0169-5347(99)001816-9. PMID 10717683.
- Lewis, L.A., and Maslin, M.A. 2015. Defining the Anthropocene. *Nature*, v. 519, p. 171-180. doi:10.1038/nature14258.
- Li, Y., Fan, X., Mitra, N.J., Charmovitz, D., Cohen-Or, D., Chen, B., and Visu, S. 2013. *Analyzing Growing Plants from 4D Point Cloud Data*.

- <http://web.siat.ac.cn/~vcc/publications/2013/Planalyze/>
- Lovelock, J.E. 1972. Gaia as seen through the atmosphere. *Atmospheric Environment* 6 (8): 579–580. doi:10.1016/0004-6981(72)90076-5
- Lovelock, J.E. 1979. *GAIA – A New Look at Life on Earth*. Oxford University Press.
- Milankovich, M. 1941. *Canon of Insolation and the Ice-Age Problem*. Israel Program for Scientific Translations. Jerusalem (1969).
- Myers, N., and Knoll, A.H. 2001. *Proc Natl Acad Sci U S A*. 2001 May 8; 98(10): 5389–5392. doi: 10.1073/pnas.091092498
- Nakayama, T., and Archibald, J. M. 2012. Evolving a photosynthetic organelle. *BMC Biology* 10 (1): 35. doi:10.1186/1741-7007-10-35.
- Ogawa, M. 2008. Mantle convection: a review. *Fluid Dynamics Research*, v. 40, p. 379 – 398.
- Oldham, R. D. 1906. The Constitution of the Interior of the Earth as Revealed by Earthquakes. *Quarterly Journal of the Geological Society of London* 62, 456-472.
- Oskin, E., 2014. Rare diamond confirms that Earth's mantle holds an ocean's worth of water. *Scientific American*.
- Pidwirny, M. 2013. *Encyclopedia of Earth*. <http://www.eoearth.org/view/article/152458/>
- Riegner, M. F. 1998. Horns, hooves, spots, and stripes: Form and pattern in mammals. In D. Seamon and A. Zajonc (Eds.), *Goethe's way of science: A phenomenology of nature*, pp. 177–212. Albany, NY: SUNY Press, Albany.
- Riegner, M. F. 2008. Parallel evolution of plumage pattern and coloration in birds: Implications for defining avian morphospace. *Condor*, v. 110, p. 599–614.
- Riegner, M.F. 2013. Ancestor of the New Archetypal Biology: Goethe's Dynamic Typology as a Model for Contemporary Evolutionary Developmental Biology, *Studies in History and Philosophy of Biological and Biomedical Sciences*, v. 44 (4), p. 735-744. doi:10.1016/j.shpsc.2013.05.019.
- Schad, W. 1977. *Man and mammals: Toward a biology of form*. Garden City, NY: Waldorf Press.
- Schad, W. 2012. *Säugetiere und mensch: Ihre gestaltbiologie in raum und zeit*, 2 bände. Stuttgart: Verlag Freies Geistesleben.
- Spiegelberg, H. 1982. *The Phenomenological Movement: An Historical Introduction*, 3rd ed. (The Hague: Martinus Nijhoff).
- Steiner, R. 1905 revised in 1918. *Knowledge of Higher Worlds*. GA 10.
- Steiner, R. 1906, 16 April. *The Interior of the Earth and Volcanic Eruptions*.
- Steiner, R. 1906, June. *Earthquakes, Volcanoes and Human Will*. S-1431.
- Steiner, R. 1907, May 25. *The nine-fold constitution of Man* p.30-31, [GA99]. Translation of “Die Theosophie des Rosenkreuzers”.
- Steiner, R. 1911. *What Has Geology to Say About the Origin of the World?* GA 60.
- Steiner, R. 1912. *The Spiritual Beings in the Heavenly Bodies and in the Kingdoms of Nature*. Lectures 1 and 2.
- Steiner, R. 1918. *Ancient Myths: Their Meaning and Connection with Evolution*. S-3463, Lecture III.
- Steiner, J. 1924a, 13 January. *A Michael Lecture*, In *Festivals and their meaning*, v. IV, Michaelmas, The significance of the Impulse of Michael.
- Steiner, R. 1988. *Goethean Science*, Mercury Press, Spring Valley, N. Y., 1988, 277 p., translated from the German by William Lindeman.

- Steiner, R. 1992. Goethe's world view. Mercury Press, Spring Valley, N. Y., translated from the German by William Lindeman. 163 p.
- Tseng, Z.J., Wang, X., Slater, G.J., Takeuchi, G.T., Li, Q., Liu, J., Xie, G. 2013. Himalayan fossils of the oldest known pantherine establish ancient origin of big cats. *Proceedings of the Royal Society B. Biological Sciences*, 81: 20132686. <http://dx.doi.org/10.1098/rspb.2013.2686>.
- USGS (US Geological Survey). 1995. http://web.ics.purdue.edu/~nowack/geos105/lect10-dir/lecture10_files/image051.jpg
- USGS (US Geological Survey). 1997. Active volcanoes, plate tectonics, and the “Ring of Fire”. http://oceanexplorer.noaa.gov/explorations/05fire/background/volcanism/media/tectonics_world_map_600.jpg
- USGS (US Geological Survey). 2013. How does the Earth's Core generate a magnetic field?” www.usgs.gov/faq/?q=categories/9782/2738.
- Valley, J.W., and 10 co-authors. 2014. Hadean age for a post-magma-ocean zircon confirmed by atom-probe tomography. *Nature Geoscience*, v. 7, p. 219–223, doi:10.1038/ngeo2075.
- Ward, P. D., and Brownlee, D. 2000. *Rare Earth: Why Complex Life is Uncommon in the Universe*. Copernicus Books, Springer Verlag.
- Weichert, E. and Geiger, L. 1910. Bestimmung des Weges der Erdbebenwellen im Erdinnern. *Physikalische Zeitschrift* 11, 294-311.
- Wöhler, F. 1828. Ueber künstliche Bildung des Harnstoffs. *Annalen der Physik und Chemie*, v. 88 (2), p. 253–256.

Appendix #1:

Subdivision of the Earth by Steiner (16th April 1906, 12 June 1906, 1907)(Fig. 16)

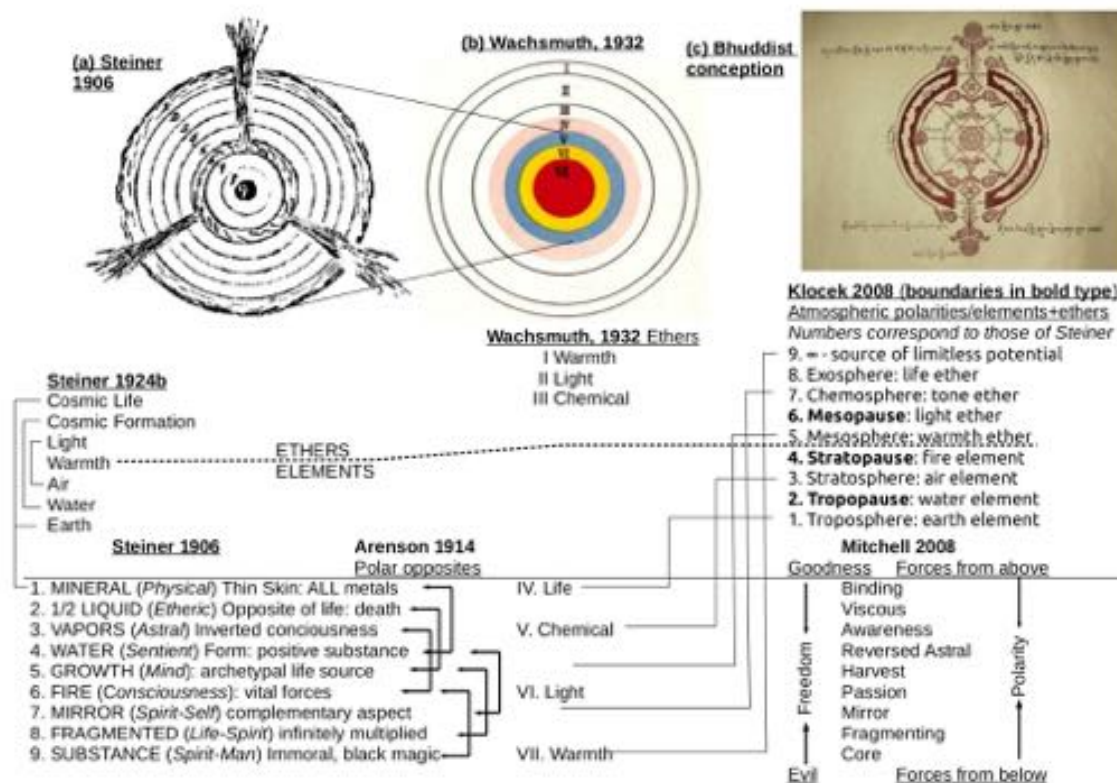


FIGURE 16. Steiner's view of the interior of the earth and its atmosphere compared with Buddhist conception (from http://4.bp.blogspot.com/-Df7bK2-71ig/TjoBsthR62I/AAAAAAAAAqW/ZKd_y8f7dKk/s1600/Tibetan%2Bsymbol%2Bof%2BAGharta.jpg) and subsequent work based on a similar metaphorical approach.

- “(1) The **mineral layer** (*physical body*) contains all the *metals* which are found in the physical bodies of everything that lives at the surface. This crust is formed like a skin around the living being of the earth. It is only a few miles in depth.
- 2) The **second layer** (*etheric body*) can only be understood if we envisage a substance which is the very opposite of what we know. It is negative life, the opposite of life. All life is extinguished there. Were a plant or an animal plunged into it, it would be destroyed immediately. It would be totally dissolved. This second shell — half liquid — which envelopes the earth is truly a sphere of death.
- 3) The **third layer** (*astral body*) is a circle of inverted consciousness. All sorrow appears there as joy. And all joy is experienced as sorrow. Its substance, composed of *vapors*, is related to our feelings in the same negative manner as the second layer is in regard to life: the transformation of feelings ...
- 4) The **fourth layer** (*sentient soul*) is known as water-earth, soul-earth, or form-earth. It is endowed with a remarkable property. Let us imagine a cube and now picture it reversed inasmuch as its substance is concerned. Where there was substance there is now nothing: the space occupied by the cube would now be empty while its substance, its substantial

form, would now be spread around it; hence the term 'earth of form.' Here this whirlwind of forms, instead of being a negative emptiness, becomes a positive substance.

5) This layer (*mind soul*) is known as the earth of growth or fruit earth. It contains the archetypal source of all terrestrial life. Its substance consists of burgeoning, teeming energies.

6) This fire-earth (*consciousness soul*) is composed of pure will, of elemental vital forces — of constant movement — shot through by impulses and passions, truly a reservoir of will forces. If one were to exert pressure on this substance it would resist.

7) This layer (*Spirit-Self*) is the mirror of the earth. It is similar to a prism which decomposes everything that is reflected in it and brings to expression its complementary aspect; seen through an emerald it would appear red.

8) In this layer (*Life-Spirit*) everything appears fragmented and reproduced to infinity. If one takes a plant or a crystal and one concentrates on this layer the plant or the crystal would appear multiplied indefinitely.

9) This kernel (*Spirit-Man*) is composed of a substance endowed with moral action. But this morality is the opposite of the one that is to be elaborated on the earth. Its essence, its inherent force, is one of separation, of discord, and of hate. It is here in the hell of Dante that we find Cain the fratricide. This substance is the opposite of everything which among human beings is good and worthy. The activity of humanity in order to establish brotherhood on the earth diminishes the power of this sphere. It is the power of Love which will transform it inasmuch as it will spiritualize the very body of the Earth. This ninth layer represents the substantial origin of what appears on earth as black magic, that is, a magic founded on egoism."

Chakras and auras of the human body (Steiner, 1905; Table 1)

The human body is inferred to be surrounded by a biomagnetic field, a donut-shaped energy field or aura, with the north and south poles corresponding to the top of the head and soles of the feet. Steiner (1905) identifies six chakras: between the eyes, near the larynx, in the region of the heart, in the so-called pit of the stomach, and two situated in the abdomen. On the other hand, many cultures identify seven, basic, biophysical, neuroelectrical connections located along the spine (progressing upwards): root, sacral/spleen, solar plexus, heart, throat, brow/third eye, crown (Budig, 2012). Opinions about the properties of the chakras differ somewhat between the various cultures.

Root chakra is described as the accumulator of earthy, stabilizing, and vital or life energy, with the quality of being grounded, strong, and steady, having willpower, and linked to the forces of nature.

Sacral chakra is thought to be the centre for polar, sensual, and sexual energy in the body, with links to lunar and solar energy and water. Also sends vitality to the Root Chakra.

Solar Plexus

chakra is said to be the centre of willpower and personal identity (ego) and is associated with aggressive mental energy and fire. Associated with feelings and emotions. Astral energy enters the etheric field at this point. According to Steiner (1905), this chakra allows knowledge of the talents and capacities of souls to be acquired, and the part played by animals, plants, stones, metals, and atmospheric phenomena becomes apparent.

Heart chakra is envisaged as the centre of love, pure affection, and caring, with interconnections to all of life. Related to sense of being, love, and higher consciousness. Steiner (1905) states that this chakra permits clairvoyant knowledge of the sentiments,

the disposition of other souls, and observation of certain deeper forces in animals and plants.

Throat chakra is seen as the centre of verbal communications and sharing nourishment. Related to voice, creativity, and thyroid. *Steiner* (1905) says that with this chakra, one can survey clairvoyantly the thoughts and mentality of other beings, and to obtain a deeper insight into the true laws of natural phenomena.

Brow chakra is related to intellectual power, mental insight/perception, visualization, concentration and memory. Development of this chakra allows one's higher ego to come into contact with higher spirits.

Crown chakra is linked to transcendental insight, spiritual revelation, divine communion, cosmic consciousness, and enlightenment.

Appendix #2: (Fig. 17)

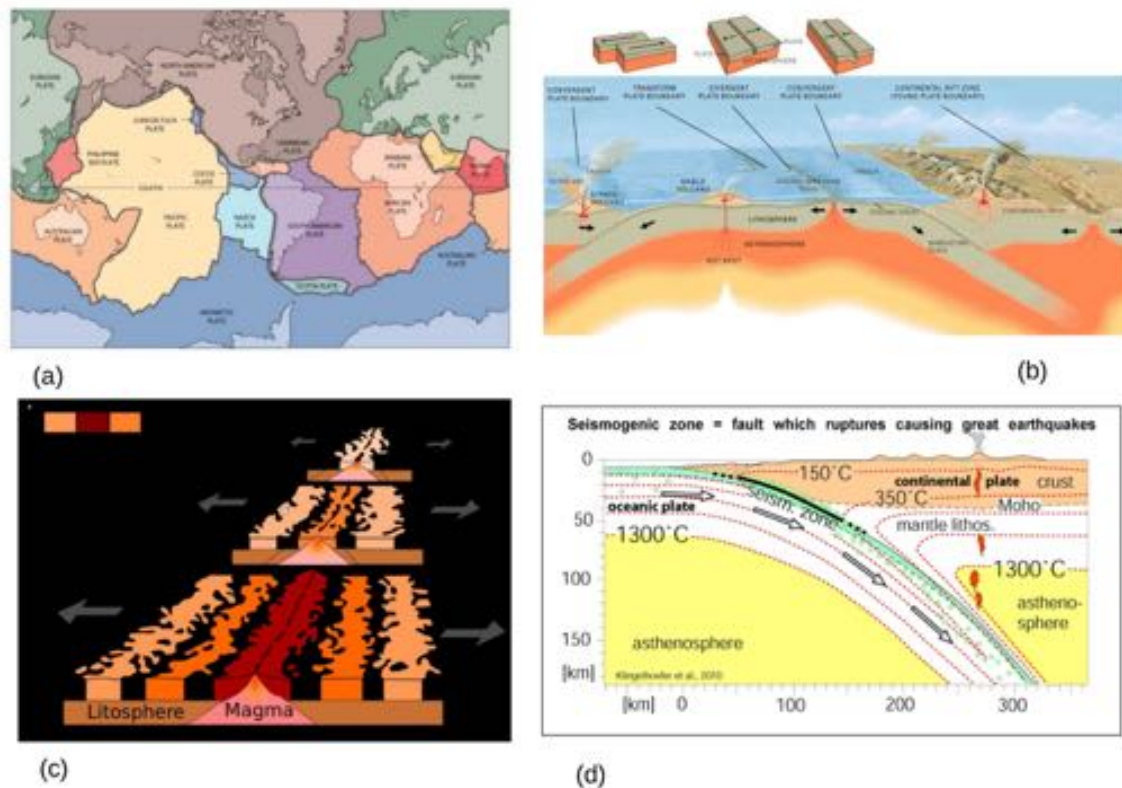


FIGURE 17.

- (a) Lithospheric plates on earth (after <http://pubs.usgs.gov/gip/dynamic/slabs.html>);
 (b) http://en.wikipedia.org/wiki/Plate_tectonics#mediaviewer/File:Tectonic_plate_boundaries.png;
 (c) <http://pubs.usgs.gov/publications/graphics/Fig7.gif>
 (d) after Klingelhoefer et al., JGR, Jan. 2010.

Subdivision of the Earth according to 21st century Natural Science

In the intervening 100 years, seismic research has culminated in the present view of the interior of the earth (Fig. 2), which includes several seismically-defined, physically distinct layers:

1. **Lithosphere and Asthenosphere** (Crust and Upper Mantle: 60-220 km thick) is solid and lies above a partially-melted, low velocity layer (Fig. 14c). The lithosphere consists of: (i) the *Crust* (between 0 and 70 km thick) composed of a wide range of silicates of Al, Fe, Ca, Na, K, Mg, etc. with the continental crust producing 30% of the earth's, radioactive heat, and (ii) the uppermost *Mantle* composed of peridotite (Fe-Mg silicates). The lithosphere is divided into seven or eight major plates and many small plates (Fig. 17a), which are composed of more dense, oceanic crust and less dense, continental crust overlying the upper mantle. Plate boundaries are either: (a) divergent, where new lithosphere is emerging at mid-oceanic ridges by seafloor spreading recording magnetic stripes as the earth's magnetic field reverses (Figs. 17b and c), (b) convergent, where one plate is plunging or subducting into the underlying mantle, which produces volcanoes

when the subducting plate reaches a depth of ca. 100 km (Fig. 17b and d), or (c) transcurrent, where plates are moving laterally past one another along transform faults (Fig. 17b). Plate motion is driven by one or more of; (i) gravity that produces sliding away from the mid-oceanic ridges on the gently dipping, low-velocity layer (slab push), or slab suction at subduction zones (slab pull) (Keppie, 2015): this process is assisted by conversion to more dense minerals with depth, e.g. amphibole to pyroxene in amphibolite and eclogite, and (iii) friction between mantle convection and the base of the lithosphere (Fig. 11c); and (iv) forces related to the earth's rotation (Neith, 2011). Dehydration of the subducted sediments and oceanic crust leads to magma generation in the overlying mantle wedge (Fig. 17d), which are extruded in volcanic chains, such as the “ring of fire” around the Pacific Ocean. The subduction process recycles both oceanic lithosphere and the leading edge of the continental lithospheric plate (Keppie *et al.*, 2009). Where motion between the subducting and overriding plates is temporarily blocked, sudden release creates intense earthquakes at depths of ca. 10-50 km at temperatures of ca. 150-350°C (Fig. 15d)(Klingelhoefer *et al.*, 2010).

2. **Lower mantle** (from base of lithosphere to 2,900 km depth) is composed of peridotite (Fe-Mg silicates) with two density (phase) changes: at 410 km where olivine becomes spinel) and at 660 km, where spinel changes to perovskite (Si^{IV} to Si^{VI}) - the latter separates the upper and lower mantles. Convection cells in the mantle (Tanimoto and Lay, 2000) are envisaged as either involving the whole asthenosphere or separate convection cells in the upper and lower mantle (Fig. 11c). Convection in the mantle recycles subducted lithosphere, which may accumulate in plate graveyards either at the 660 km discontinuity or at the mantle/core boundary: melting of these accumulations produces rising currents and plumes (Fig. 11c). Rising currents appear as mid-oceanic ridges, over which there is high heat flow: most ridges lie beneath the sea and only rarely break the surface, e.g. Iceland. On the other hand, plumes produce isolated volcanoes or volcanic chains as the lithospheric plates move over the plume, e.g. Hawaiian island chain.

3. **Core** consists of two parts, liquid inner core and solid outer core. The Inner core (2,900-5155 km depth) is composed of liquid Fe-Ni-S with convection cells, which produces a dynamo (Fig. 14a). The convection cells or vortices consist of electrical charged particles that produce the earth's magnetic field (Fig. 14a)(Christensen, 2011, *Geodynamo: USGS*, 2013). The orientation of the vortices is controlled by the Coriolis Force and the convection is driven by heat flow from the inner core. Periodic reversals of the magnetic field have been recorded in the ocean floor and have been modelled by Glatzmaier and Roberts (1995). *The Inner Core (5,155-6371 km depth) is composed mainly of solid Fe-Ni alloy, with minor quantities of gold, platinum and siderophile elements.* The inner core is inferred to be crystalline with a hexagonal or cubic structure that may be aligned (Lythgoe *et al.*, 2014).

Appendix #3:

Forces, Fields, Energy and Elementary Particles

The earth is the source of two of the fundamental forces in the universe, *gravity and electromagnetic*, which produce fields, whose strength varies inversely with distance, and they act over infinite distances and are experienced by all living organisms.

Electromagnetism is strong and attracts and repels, whereas gravity only attracts. The other two fundamental forces are the strong and weak nuclear forces, and operate at the atomic scale. All four involve the exchange of one or more particles.

The Force of **Gravity** involves the exchange of the *graviton* and although the graviton has not yet been observed directly, violent events in the universe are inferred to produce gravitational waves (ripples in the space-time fabric), such as the coalescence of stars, black holes, pulsars and those produced by supernovae in the milky way and in outer galaxies. Gravitational waves are currently being sought (<http://www.ego-gw.it/virgodescription>). The graviton has a zero mass when at rest. Gravity produces convection in the outer core, asthenosphere, oceans and troposphere, and causes lithospheric slab-pull. Subducted lithosphere may be extruded back to the surface, or accumulate in slab graveyards at depths of ca. 660 km and at the mantle-core boundary (Spasojevic et al., 2010). Melting of these accumulations appears to be the source of mantle plumes and mid-oceanic ridges, which rejuvenates the surface of the earth with the birth of new lithosphere through volcanism. The earth's atmosphere is held in place by gravity, whose magnitude is dependant on the size of the earth. Water vapour in the troposphere regulates surface temperatures by absorbing solar energy and thermal radiation from the earth's surface. The air in the lowest part of the atmosphere is free of harmful radiation and has the right mixture to support life. Temperature differences are felt by one's sense of warmth, whereas water vapour is detected in respiration. Ozone in the stratosphere absorbs hazardous ultraviolet radiation and so provides conditions on the earth's surface suitable for life (ESA, 2012). Charged particles of earthly origin in the mesosphere and thermosphere moderate extra-terrestrial radiation, specifically the ionosphere blocks x-rays and extreme ultraviolet radiation (Fig. 18). The force of gravity is centred in the inner core of the earth where the highest densities occur. However, all the material beneath the earth's surface add to the gravitational force experienced on the surface. The gravitational force decreases with altitude. In humans it gives rise to a sense of balance.

The **electromagnetic** force involves both the attraction and repulsion of electric charges that hold molecules and atoms together. The other three fundamental forces are relatively negligible compared with electrical force. Magnetic and electric forces involve the exchange of *photons* between two charged particles, i.e. a quantum of light or other electromagnetic radiation. The infinite range of the electromagnetic force is due to the zero rest mass of the photon. Convection in the outer core of the earth produces the magnetic field that inversely diminishes with square of the distance from the core-mantle boundary. The magnetosphere deflects most of the solar wind and cosmic rays, which shields the upper atmosphere from erosion, thereby protecting the earth and all life from the charged particles. Although some animals use the earth's magnetic field for orientation and navigation, it has only recently been shown that human retinas may be magnetosensitive (Foley et al., 2011).

The **strong nuclear force** is the strongest of the four fundamental forces, but it's

range is limited to the atomic nucleus. Gluons are the exchange particles for the colour force between quarks. The strong nuclear force binds together: (a) the protons and neutrons that form the nucleus of the atom, and (b) quarks to one another that form protons, neutrons, and other hadron particles. Release of the binding energy gives rise to nuclear power. Without the strong nuclear force there would be no life.

The **weak nuclear force** also has a limited range (ca. 0.1% diameter of a proton), and it facilitates decay of nuclear particles to form heavy nuclei, and the formation and fusion of deuterium, which causes the sun to burn. The weak nuclear force involves the exchange of W and Z, intermediate vector bosons. Radioactive decay arises in all the layers of the earth, and has existed since the earth formed, 4.54 billion years ago (Grant, 1996). The heat produced by radioactive decay is released by convection, conduction and advection; ca. 24% from the crust, ca. 54% from the mantle, and ca. 22% from the core (Fig. 11). Most of radioactive decay originates in uranium (32%), thorium (32%) and potassium (16%), which produces about half of the heat flowing from the earth (KanLAND, 2011). The other 50% is assumed to be residual primordial heat migrating to the earth's surface (Turcotte and Schubert, 2002). Heat flow is highest where mantle material rises to the earth's surface over the mid-oceanic ridges and plumes (Fig. 12b). Heat generated by the earth is only 0.03% of the energy encountered at the earth's surface, most of which is provided by the sun (Archer, 2012)(Fig. 11). The combined heat from within the earth combined with the sun's radiation is felt by the sense of warmth. The origin of radioactive elements is thought to have originated during the creation of the universe, i.e. the Big Bang (Peebles et al., 1994). However, according to Stephan Hawking (2010) "in the "no boundary" proposal, the history of the universe in imaginary time is like the surface of the earth: it is finite in size but doesn't have a boundary", and there are no singularities, such as the Big Bang. In the no boundary model, the universe can be envisaged as expanding from a 'North Pole' in a chaotic inflationary model until it reaches the Equator when it begins to collapse back to the 'South Pole'. This cycle is then repeated. Early expansion mainly produced hydrogen and helium that subsequently coalesced into supernovae, which underwent gravitational collapse causing fusion of lighter elements to produce heavy elements, such as the isotopes of nickel, iron, cobalt, manganese, chromium, vanadium, titanium, and other elements, e.g. silicon, sulphur, chlorine, argon, sodium, potassium, calcium and scandium, which were subsequently incorporated into the solar system and the earth. The early expansion is also inferred to have produced the strong and weak nuclear forces.

Appendices References

- Archer, D. 2012. *Global Warming: Understanding the Forecast*, Wiley Press.
- Arenson, A. 1914. The interior of the earth. Lecture:
<http://www.rsarchive.org/RelAuthors/ArensonA/InterioroftheEarth.php>.
- Budig, K. 2012. *The Women's Health Big Book of Yoga: The Essential Guide to Complete Mind/Body Fitness*.
- Christensen, U.R. 2011. Geodynamo models: Tools for understanding properties of Earth's magnetic field. *Physics of the Earth and Planetary Interiors*, 187, 157–169.
- Cosmicopia, 2012. <http://helios.gsfc.nasa.gov/magnet.html>.
- ESA. 2012.
http://www.esa.int/Our_Activities/Space_Science/Earth_s_magnetic_field_provides_vital_protection.
- Foley, G.E., Gegear, R.J., and Reppert, S.M. 2011. Human cryptochrome exhibits light-dependent magnetosensitivity. *Nature Communications*, v. 2, p. 356-359. DOI: 10.1038/ncomms1364.
- Glatzmaier, G. A. and Roberts, P. H. 1995. A three-dimensional self-consistent computer simulation of a geomagnetic field reversal. *Nature* **377** (6546): 203–209.
- Grant, N. 1996. Radioactivity in the history of the Earth. *Newsletter Articles Supplement*, no. 2, p. 12-30.
- Hawking, S. 2010. *The illustrated brief history of time*. Bantam Dell, NY, 248 p.
- KamLAND. 2006. First Measurement of Geoneutrinos at KamLAND. *Research/News*:
<http://www2.lbl.gov/Science-Articles/Archive/NSD-KamLAND-geoneutrinos.html>
- KamLAND collaborators. 2011. Partial radiogenic heat generation model for earth revealed by geoneutrino measurements. *Nature Geoscience*, v. 4, p. 647-651.
- Keppie, D.F., Currie, C.A., and Warren, C. 2009. Subduction erosion modes: Comparing finite element numerical models with the geological record. *Earth and Planetary Science Letters*, v. 287, p. 241–254.
- Keppie, D.F. 2015. How the closure of paleo-Tethys and Tethys oceans controlled the early breakup of Pangaea. *Geology*. doi:10.1130/G36268.1.
- Klingelhoefer, Gutscher, et al. 2010. Limits of the seismogenic zone in the epicentral region of the 26 December 2004 great Sumatra-Andaman earthquake: Results from seismic refraction and wide-angle reflection surveys and thermal modeling. *Journal of Geophysical Research*, v. 115, B01304, doi:10.1029/2009JB006569, 2010.
- Klocek, D. 2008. As above, so below. In *The Inner Life of the Earth, Exploring the Mysteries of Nature, Subnature, and Supranature*, P.V. O'Leary (ed.), Steiner Press, p. 39-68.
- Lythgoe, K.H., Deuss, A., Rudge, J.F., and Neufeld, J.A. 2014. Earth's inner core: Innermost inner core or hemispherical variations? *Earth and Planetary Science Letters*, v. 385, p.181–189.
- Mitchell, D.S. 2008. Evil: our dance partner through life. In *The Inner Life of the Earth, Exploring the Mysteries of Nature, Subnature, and Supranature*, P.V. O'Leary (ed.), Steiner Press, p. 1-38.
- NASA. 2014. <http://astrobob.areavoices.com/tag/earth/> Naydler, J. (ed.) 1996. *Goethe on Science*. Floris Books, 141 p.
- Neith, K. April 15, 2011. Caltech researchers use GPS data to model effects of tidal loads on Earth's surface. Caltech. Retrieved August 15, 2012.

- Peebles, P.J.E., Schramm, D.N., Turner, E.L. & R.G. Kron 1994, "The Evolution of the Universe", Scientific American, 271, 29 - 33.
- Roberts Artal, L. 2013. Guest Post: Solar Storms and the Earth's Protective Shield. European Geophysical Union.
<http://blogs.egu.eu/network/geosphere/2013/03/15/guest-post-solar-storms-and-the-earths-protective-shield-laura-roberts-artal/>
- Spasojevic, S., Gurnis, M., and Sutherland, R. 2010. Mantle upwellings above slab graveyards linked to the global geoid lows. *Nature Geoscience* **3** (6): 435.
doi:10.1038/NGEO855.
- Steiner, R. 1883. Einleitung zu Goethes Naturwissenschaftliche Schriften. ISBN 3-7274-5180-7.
- Steiner, R. 1906, 4 September. Lecture 14: Rosicrucian training – the interior of the earth – earthquakes and volcanoes, Schmidt Number: S-1376.
- Steiner, R. 1909. *The Principle of Spiritual Economy*, GA 111, 11/6/1909.
- Steiner, R. 1911, 28 December. Good and Evil: creation and death, in Evil, Rudolf Steiner Press, 1997.
- Steiner, R. 1924b, 14 and 21 March. Lessons 5 and 6, Esoteric Lessons for the First Class of the Free School for Spiritual Science at the Goetheanum.
- Tanimoto, T., and Lay, T. 2000. Mantle dynamics and seismic tomography. *Proceedings National Academy of Science, USA*. v. 97/#23, p. 12409–12410, doi: 10.1073/pnas.210382197.
- Turcotte, D.L., and Schubert, G. 2002. Cambridge University Press, 456p.
- USGS (US Geological Survey). 2007. <http://sciencelearn.org.nz/Contexts/Icy-Ecosystems/Sci-Media/Images/Crustal-plates>
- Wachsmuth, G. 1932. The etheric formative forces in the cosmos, earth and man. The Anthroposophical Publication Co., London and New York, v. 1, 244 p.