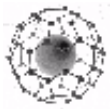

THE GEOLOGY OF MORALS

A Neo-Materialist Interpretation

by Manuel De Landa.

The distinction between institutions which emerge from centralized and decentralized decision-making by its human components has come to occupy center-stage in several different contemporary philosophies. Economist and Artificial Intelligence guru Herbert Simon, for example, views bureaucracies and markets as the human institutions which best embody these two conceptions of control. {1} Hierarchical institutions are the easiest ones to analyze, since much of what happens within a bureaucracy in planned by someone of higher rank, and the hierarchy as a whole has goals and behaves in ways that are more or less consistent with those goals. Markets, on the other hand, are tricky. Indeed, the term "market" needs to be used with care because it has been greatly abused over the last century by theorists on the left and the right. As Simon remarks, the term does not refer to the world of corporations, whether monopolies or oligopolies, since in these commercial institutions decision-making is highly centralized, and prices are set by command.

I would indeed limit the sense of the term even more to refer exclusively to those weakly gatherings of people at a predefined place in town, and not to a dispersed set of consumers catered by a system of middleman (as when one speaks of the "market" for personal computers). The reason is that, as historian Fernand Braudel has made it clear, it is only in markets in the first sense that we have any idea of what the dynamics of price formation are. In other words, it is only in peasant and small town markets that decentralized decision-making leads to prices setting themselves up in a way that we can understand. In any other type of market economists simply assume that supply and demand connect to each other in a functional way, but they do not give us any specific dynamics through which this connection is effected. {2} Moreover, unlike the idealized version of markets guided by an "invisible hand" to achieve an optimal allocation of resources, real markets are not in any sense optimal. Indeed, like most decentralized, self-organized structures, they are only viable, and since they are not hierarchical they have no goals, and grow and develop mostly by drift.

Herbert Simonis distinction between command hierarchies and decentralized markets may turn out to be a special case of a more general dichotomy. In the view of philosophers Gilles Deleuze and Felix Guattari, this more abstract classes, which they call strata and self-consistent aggregates (or trees and rhizomes), are defined not so much by the locus of control, as by the nature of the elements that are connected together. Strata are composed of homogenous elements, whereas self-consistent aggregates, or to use the term I prefer, meshworks, articulate heterogeneous elements as such. {3} For example, a military hierarchy allocates people into internally homogenous ranks before joining them together through a chain of command. Markets, on the other hand, allow for a set of heterogeneous needs and offers to become articulated through the price mechanism, without reducing their diversity.

As both Simon and Deleuze and Guattari emphasize, the dichotomy between hierarchies and markets, or more generally, between strata and meshworks, should be understood in purely relative terms. In the first place, in reality it is hard to find pure cases of these two structures: even the most goal-oriented organization will still show some drift in its growth and development, and most markets even in small towns contain some hierarchical elements, even if it is just the local wholesaler which manipulates prices by dumping (or withdrawing) large amounts of a product on (or from) the market. Moreover, hierarchies give rise to meshworks and meshworks to hierarchies. Thus, when several bureaucracies coexist (governmental, academic, ecclesiastic), and in the absence of a super-hierarchy to coordinate their interactions, the whole set of institutions will tend to form a meshwork of hierarchies, articulated mostly through local and temporary links. Similarly, as local markets grow in size, as in those gigantic fairs which have taken place periodically since the Middle Ages, they give rise to commercial hierarchies, with a money market on top, a luxury goods market underneath and, after several layers, a grain market at the bottom. A real society, then, is made of complex and changing mixtures of these two types of structure, and only in a few cases it will be easy to decide to what type a given institution belongs.

The dichotomy between strata and meshworks can be usefully applied in a wide variety of contexts. For instance, animal species may be considered biological instantiations of a stratified structure while ecosystems may be treated as meshworks. This raises the question of whether some (or most) of the applications of these terms are purely metaphorical. There is, no doubt, some element of metaphor in my use of the terms, but behind the appearance of linguistic analogy there are, I believe, common physical processes behind the formation of real meshworks and strata which make all the different usages of the terms quite literal. These common processes cannot be captured through

linguistic representations alone and we need to move to the realm of engineering diagrams to specify them.

Perhaps a concrete example will help clarify this rather crucial point. When we say (as Marxists used to say) that "class struggle is the motor of history" we are using the word "motor" in a purely metaphorical sense. However, when say that "a hurricane is a steam motor" we are not simply making a linguistic analogy: rather we are saying that hurricanes embody the same diagram used by engineers to build steam motors, that is, that it contains a reservoir of heat, that it operates via thermal differences and that it circulates energy and materials through a (so-called) Carnot cycle. Deleuze and Guattari use the term "abstract machine" to refer to this diagram shared by very different physical assemblages. Thus, there would be an "abstract motor" with different physical instantiations in technological objects and natural atmospheric processes.

What I would like to argue here is that there are also abstract machines behind the structure-generating processes which yield as historical products specific meshworks and hierarchies. Let us begin by discussing the case of hierarchical structures, and in particular, of social strata (classes, castes). The term "social stratum" itself is clearly a metaphor, involving the idea that just as geological strata are layers of rocky materials stacked on top of each other so classes and castes are like layers of human materials in which some are higher and some lower. Is it possible to go beyond metaphor and show that the genesis of both geological and social strata involve the same engineering diagram?. Geological strata (accumulations of sedimentary rocks like sandstone or limestone) are created through a process involving (at least) two distinct operations. When one looks closely at the layers of rock in an exposed mountain side, one striking characteristic is that each layer contains further layers, each composed of small pebbles which are nearly homogenous with respect to size, shape and chemical composition. Since pebbles in nature do not come in standard sizes and shapes, some kind of sorting mechanism needs to be involved here, some specific device to take a multiplicity of pebbles of heterogeneous qualities and distribute them into more or less uniform layers.

Geologists have uncovered one such mechanism: rivers acting as veritable hydraulic computers (or at least, sorting machines). Rivers transport rocky materials from their point of origin (a previously created mountain subject to erosion or weathering) to the place in the ocean where these materials will accumulate. In this process, pebbles of variable size, weight and shape tend to react differently to the water transporting them. These different reactions to moving water are what sorts the pebbles, with the small ones reaching the ocean sooner than the large ones, for example. Once the raw materials have

been sorted out into more or less homogenous groupings deposited at the bottom of the sea (that is, once they have become sedimented), a second operation is necessary to transform these loose collections of pebbles into an entity of a higher scale: a sedimentary rock. This operation consists in cementing the sorted components together into a new entity with emergent properties of its own, that is, properties such as overall strength and permeability that cannot be ascribed to the sum of the individual pebbles. This second operation is carried out by certain substances dissolved in water (such as silica or hematite in the case of sandstones) which penetrate the sediment through the pores between pebbles. As this percolating solution crystallizes, it consolidates the pebble's temporary spatial relations into a more or less permanent "architectonic" structure. {4}

Thus, a double operation, a "double articulation" gets us from structures at one scale to structures at another scale. Deleuze and Guattari call these two operations "content" and "expression" , and warn us against confusing them with the old philosophical distinction between "substances" and "forms". The reason is that each one of the two articulations involves substances and forms: sedimentation is not just about accumulating pebbles (substance) but also about sorting them into uniform layers (form); while consolidation not only effects new architectonic couplings between pebbles (form) but also yields a new entity, a sedimentary rock (substance). Moreover, these new entities may themselves accumulate and sort (as in the alternating layers of schist and sandstone that make up Alpine mountains) and become consolidated when tectonic forces cause the accumulated layers of rock to fold and become a higher scale entity, a mountain. {5}

In the model proposed by Deleuze and Guattari these two operations constitute an engineering diagram and therefore we can expect to find this "abstract machine of stratification" not only in the world of geology, but also in the organic and human worlds. For example, according to neo-Darwinism species form through the slow accumulation of genetic materials, and of the adaptive anatomical and behavioral traits that those genetic materials yield when combined with nonlinear dynamical processes (such as the interaction of cells during the development of an embryo). Genes, of course, do not merely deposit at random but are sorted out by a variety of selection pressures which include climate, the action of predators and parasites and the effects of male or female choice during mating. Thus, in a very real sense, genetic materials "sediment" just as pebbles do, even if the nonlinear dynamical system which performs the sorting operation is completely different in detail. Furthermore, these loose collections of genes can (like accumulated sand) be lost under some drastically changed conditions (such as the onset of an Ice age) unless they become

consolidated together. This second operation is performed by "reproductive isolation": when a given subset of a population becomes incapable of mating with the rest (or as in the case of horses and donkeys, when their offspring are sterile). Reproductive isolation acts as a "ratchet mechanism" which conserves the accumulated adaptation and makes it impossible for a given population to "de-evolve" all the way back to unicellular organisms. Through selective accumulation and isolative consolidation, individual animals and plants come to form a higher scale entity: a new species. {6}

We can also find these two operations (and hence, this abstract diagram) in the formation of social classes. We talk of "social strata" whenever a given society presents a variety of differentiated roles to which not everyone has equal access, and when a subset of those roles (i.e. those to which a ruling elite alone has access) involves the control of key energetic and material resources. While role differentiation may be a spontaneous effect of an intensification in the flow of energy through society (e.g. as when a Big Man in pre-State societies acts as an intensifier of agricultural production), the sorting of those roles into ranks along a scale of prestige involves specific group dynamics. In one model, for instance, members of a group who have acquired preferential access to some roles begin to acquire the power to control further access to them, and within these dominant groups criteria for sorting the rest of society into sub-groups begin to crystallize. "It is from such crystallization of differential evaluation criteria and status positions that some specific manifestations of stratification and status differences -such as segregating the life-styles of different strata, the process of mobility between them, the steepness of the stratificational hierarchies, some types of stratum consciousness, as well as the degree and intensity of strata conflict- develops in different societies." {7}

However, even though most societies develop some rankings of this type, not in all of them do they become an autonomous dimension of social organization. In many societies differentiation of the elites is not extensive (they do not form a center while the rest of the population forms an excluded periphery), surpluses do not accumulate (they may be destroyed in ritual feasts), and primordial relations (of kin and local alliances) tend to prevail. Hence a second operation is necessary beyond the mere sorting of people into ranks for social classes or castes to become a separate entity: the informal sorting criteria need to be given a theological interpretation and a legal definition, and the elites need to become the guardians and bearers of the newly institutionalized tradition, that is, the legitimizers of change and delineators of the limits of innovation. In short, to transform a loose accumulation of traditional roles (and criteria of access to those roles) into a social class, the latter needs to become consolidated via theological and legal codification. {8}

My main point can then be stated as follows: sedimentary rocks, species and social classes (and other institutionalized hierarchies) are all historical constructions, the product of definite structure-generating processes which take as their starting point a heterogeneous collection of raw materials (pebbles, genes, roles), homogenize them through a sorting operation and then give the resulting uniform groupings a more permanent state through some form of consolidation. Hence, while some elements remain different (e.g. only human institutions, and perhaps, biological species, involve a hierarchy of command) others stay the same: the articulation of homogenous components into higher-scale entities. (And all this, without metaphor).

What about meshworks?. Deleuze and Guattari also offer a hypothetical diagram for this type of structure, but its elements are not as straightforward as those involved in the formation of strata. For this reason I will begin the description of this other abstract machine with some remarks about what mathematical and computer models of meshworks have revealed about their formation and behavior, and then attempt to derive their engineering diagram. Perhaps the best studied type of meshwork is the so called "autocatalytic loop", a closed chain of chemical processes involving not only self-stimulation but also self-maintenance, that is, interconnecting a series of mutually-stimulating pairs into a structure which reproduces as a whole: a product that accumulates due to the catalytic acceleration of one chemical reaction serves as the catalyst for yet another reaction which, in turn, generates a product which catalyses the first one. Hence, the loop becomes self-sustaining as long as its environment contains enough raw materials for the chemical reactions to proceed.

Francisco Varela and Humberto Maturana, pioneers in the study of autocatalytic loops (e.g. their theory of "autopoeisis") mention two general characteristics of these closed circuits: they are dynamical systems which endogenously generate their own stable states (called "attractors" or "eigenstates"), and they grow and evolve by drift. . {9} An example of the first characteristic are some chemical reactions involving autocatalysis (as well as cross-catalysis) which function as veritable "chemical clocks", in which the accumulation of materials from the reactions alternate each other at perfectly regular intervals . This rhythmic behavior is not imposed to the system from the outside but generated spontaneously from within (via an attractor). {10}

The second characteristic mentioned by Varela and Maturana, growth by drift, may be explained as follows. In the simplest autocalytic loops there are only two reactions, each producing a catalyst for the other. But once this basic two-node network establishes itself, new nodes may insert themselves into the mesh as long as they do not jeopardize its internal consistency. Thus, a new chemical

reaction may appear (using previously neglected raw materials or even waste products from the original loop) which catalyses one of the original ones and is catalyzed by the other, so that the loop now becomes a three-node network. The meshwork has now grown but in a direction which is, for all practical purposes, "unplanned". A new node (which just happens to satisfy some internal consistency requirements) is added and the loop complexifies, yet precisely because the only constraints were internal, the complexification does not take place in order for the loop as a whole to meet some external demand (such as adapting to a specific situation). The surrounding environment, as source of raw materials, certainly constraints the growth of the meshwork but more in a proscriptive way (what not to do) than in a prescriptive one (what to do). {11}

The question now is whether from these and other empirical studies of meshwork behavior we can derive a structure-generating process which is abstract enough to operate in the worlds of geology, biology and human society. In the model proposed by Deleuze and Guattari, there are three elements in this diagram. First, a set of heterogeneous elements is brought together via an articulation of superpositions , that is, an interconnection of diverse but overlapping elements. (In the case of autocatalytic loops, the nodes in the circuit are joined to each other by their functional complementarities). Second, a special class of operators, or intercallary elements, is needed to effect this interlock via local connections. (In our case, this is the role played by catalysts, inserting themselves between two other chemical substances to facilitate their interaction). Finally, the interlocked heterogeneities must be capable of endogenously generating stable patterns of behavior (for example, patterns at regular temporal or spatial intervals.) {12} Is it possible to find instances of these three elements in all different spheres of reality?

Besides the sedimentary type there exists another great class of rocks called "igneous rocks" (such as granite) which are the outcome of a radically different process of construction. Granite forms directly out of a cooling magma, a viscous fluid made out of a diversity of molten materials. Each of these liquid components has a different threshold of crystallization, that is, each undergoes the bifurcation towards the solid state at a different critical point in temperature. This means that as the magma cools down its different elements will separate as they crystallize in sequence, those that solidify earlier serving as containers for those which acquire a crystal form later. In these circumstances the result is a complex set of heterogeneous crystals which interlock with one another, and this is what gives granite its superior strength. {13}

The second element in the diagram, intercallary elements, must be defined more generally than just as catalytic substances, to include anything which brings

about local articulations from within, "densifications, intensifications, reinforcements, injections, showerings , like so many intercallary events". {14} The reactions between liquid magma and the walls of an already crystallized component, nucleation events within the liquid which initiate the next crystallization, and even certain "defects" inside the crystals (called "dislocations") which promote growth from within, are all examples of intercallary elements. Finally, chemical reactions within the magma may also generate endogenous stable states.

When a reaction like the one involved in chemical clocks is not stirred, the temporal intervals generated become spatial intervals, forming beautiful spiral and concentric circle patterns which sometimes can be observed in frozen form in some igneous rocks. {15}

Thus, granite (as much as a fully formed autocatalytic loop) is an instance of a meshwork, or in the terms used by Deleuze and Guattari, of a self-consistent aggregate. Unlike Varela and Maturana, for whom this quality of self-consistency exists only in the biological and linguistic worlds, for Deleuze and Guattari "consistency, far from being restricted to complex life forms, fully pertains even to the most elementary atoms and particles". {16} Therefore we may say that much as hierarchies (organic or social) are special cases of a more abstract class, "strata", so autocatalytic loops are special cases of "self-consistent aggregates". And much as strata are defined as an articulation of homogenous elements (and do not involve more specific features of hierarchies such as having a chain of command), so self-consistent aggregates are defined by their articulation of heterogeneous elements and do not necessarily involve other, less general, features (such as growth by drift or internal autonomy). Let us now give some biological and cultural examples of the way in which the diverse may be articulated as such via self-consistency.

As I just mentioned, a species (or more precisely, the gene pool of a species) is a prime example of an organic stratified structure. Similarly, an ecosystem represents a biological realization of a self-consistent aggregate. While a species may be a very homogenous structure (specially if selection pressures have driven many genes to fixation) an ecosystem links together a wide variety of heterogeneous elements (animals and plants of different species) which are articulated through interlock, that is, by their functional complementarities. Given that the main feature of an ecosystem is the circulation of energy and matter in the form of food, the complementarities in question are alimentary: prey-predator or parasite-host are two of the most common functional couplings that make up food webs. In this situation, symbiotic relations can act as intercallary elements aiding the process of building food webs, with the most obvious example being

the bacteria that live in the guts of many animals and which allow those animals to digest their food. Since food webs also display endogenously generated stable states, all three components of the abstract diagram seem to be realized in this case.

I have already mentioned that markets may be considered examples of cultural meshworks. In many cultures weekly markets have traditionally been the meeting place for people with heterogeneous needs and offers. Matching complementary demands (that is, interlocking these people together by their needs and offers) is an operation which is performed automatically by the price mechanism. (Prices transmit not only information about the relative monetary value of different products, but also incentive to buy and sell). All that is needed for this automatic mechanism to work is that prices drop in the face of an excess supply and that quantities produced and offered decline when prices are lowered.

Of course, for this to work prices must set themselves, and therefore we must imagine that there is not a wholesaler in town who can manipulate prices by dumping (or hoarding) large amounts of a given product into the market. In the absence of price manipulation, money (even primitive money such as salt, shells or cigarettes) performs the function of intercallary element: while with pure barter the possibility of two exactly matching demands meeting by chance is very low, with money those chance encounters become unnecessary, and complementary demands may find each other at a distance, so to speak. Finally, markets also seem to generate endogenous stable states, particularly when commercial towns form trading circuits, as can be seen in the cyclic behavior of their prices.

Thus, much as sedimentary rocks, biological species and social hierarchies are all particular cases of a stratified system (that is, they are all historical products of a process of double articulation), so igneous rocks, ecosystems and markets are self-consistent aggregates (or meshworks), the result of the coming together and interlocking of heterogeneous elements. This conception of very specific abstract machines governing a variety of structure-generating processes not only blurs the distinction between the natural and the artificial, but also that between the living and the inert. It indeed points towards a new form of materialist philosophy in which raw matter-energy through a variety of self-organizing processes and an intense power of morphogenesis, generates all the structures that surround us. Furthermore, the structures generated cease to be the primary reality, and matter-energy flows now acquire this special status.

From the point of view of the nonlinear dynamics of our planet, the thin rocky crust on which we live and which we call our land and home is perhaps its least important component. Indeed, if we waited long enough, if we could observe

planetary dynamics at geological time scales, the rocks and mountains which define the most stable and durable traits of our reality would dissolve into the great underground lava flows of which they are but temporary hardenings. Indeed, given that it is just a matter of time for any one rock or mountain to be reabsorbed into the self-organized flows of lava driving the dynamics of the lithosphere, these geological structures represent a local slowing-down in this flowing reality. It is almost as if every part of the mineral world could be defined by specifying its chemical composition and its speed of flow : very slow for rocks, faster for lava.

Similarly, our individual bodies and minds are mere coagulations or decelerations in the flows of biomass, genes, memes and norms. Here too we would be defined both by the materials we are temporarily binding or chaining into our organic bodies and cultural minds, as well as by the time scale of the binding operation. Given long enough time scales, it is the flow of biomass through food webs that matters, as well as the flow of genes through generations, and not the bodies and species that emerge in these flows. Given long enough time scales, our languages are also momentary slowing-downs or thickenings in a flow of norms that can give rise to a multitude of different structures. The overall world-view that this "geological philosophy" generates may be put into a nut shell by introducing some special technical terminology.

First of all, the fact that meshworks and hierarchies occur mostly in mixtures, makes it convenient to have a label to refer to these changing combinations. If the hierarchical components of the mix dominate over the meshwork ones we may speak of a highly stratified structure, while the opposite combination will be referred to as one with a low degree of stratification. Moreover, since meshworks give rise to hierarchies and hierarchies to meshworks, we may speak of a given mixture as undergoing processes of destratification as well as restratification, as its proportions of homogenous and heterogeneous components change. Finally, since according to this way of viewing things what truly defines the real world are neither uniform strata nor variable meshworks but the unformed and unstructured morphogenetic flows from which these two derive, it will also be useful to have a label to refer to this special state of matter-energy-information, to this flowing reality animated from within by self-organizing processes constituting a veritable non-organic life : the Body without Organs (BwO):

"The organism is not at all the body, the BwO; rather it is a stratum on the BwO, in other words, a phenomenon of accumulation, coagulation, and sedimentation that, in order to extract useful labor from the BwO, imposes upon it forms, functions, bonds, dominant and hierarchized organizations, organized

trascendences...the BwO is that glacial reality where the alluvions, sedimentations, coagulations, foldings, and recoilings that compose an organism -and also a signification and a subject- occur. " {17}

The label itself is, of course, immaterial and insignificant. We could as well refer to this cauldron of non-organic life by a different name. (Elsewhere, for instance, I called it the "machinic phylum"). {18} Unlike the name, however, the referent of the label is of extreme importance, since the flows of lava, biomass, genes, memes, norms, money (and many others) are crucial for the emergence of just about any stable structure that we cherish and value (or, on the contrary, that oppresses and slaves us). We could define the BwO in terms of this unformed, destratified flows, as long as we keep in mind that what counts as destratified at any given time and space scale is entirely relative. The flow of genes and biomass are "unformed" if we compare them to any given individual organism, but they themselves have internal forms and functions. Indeed, if instead of taking a planetary perspective we adopted a properly cosmic viewpoint, our entire planet (together with its flows) would itself be a mere provisional hardening in the vast flows of plasma which permeate the universe.

Human history has involved a variety of Bodies without Organs. First, the sun, that giant sphere of plasma which intense flow of energy drives most processes of self-organization in our planet, and in the form of grain and fossil fuel, in our civilizations. Second, the body of lava "conveyor belts" (convection cells) which drive plate tectonics and which are responsible for the most general geopolitical features of our planet, such as the breakdown of Pangea into our current continents, and the subsequent distribution of domesticable species, a distribution that benefited Eurasia over the rest of the world. Third, the BwO constituted by the coupled dynamics of the Hydrosphere/Atmosphere, and their wild variety of self-organized entities: hurricanes, tsunamis, pressure blocks, cyclones, and wind circuits. (The conquest of the wind circuits of the Atlantic, the trade winds and the westerlies, is what allowed the transformation of the American continent into a vast supply zone to fuel the growth of the European urban economy).

Fourth, the genetic BwO constituted by the more or less free flow of genes through microorganisms (via plasmids and other vectors), which unlike the more stratified genetic flow in animals and plants, has avoided human control even after the creation of antibiotics. Fifth, those portions of the flow of solar energy through ecosystems (flesh circulating in natural food webs) which have escaped urbanization, particularly animal and vegetable weeds or rhizomes (The BwO formed by underground rodent cities, for example). Finally, our languages, when they formed dialect continua and circumstances conspired to remove any

stratifying pressure, also formed a BwO, as when the Norman invaders imposed French as the language of the elites allowing the peasant masses to create the English language out of an amorphous soup of Germanic norms with Scandinavian spices.

Immanent to the BwO are a set of abstract machines, engineering diagrams capturing the dynamics of certain structure-generating processes. The two most general may be those behind the formation of strata and self-consistent aggregates. But there are others. For instance, when the sorting device is coupled with the ability to replicate with variation, a new abstract machine emerges, this time a blind probe head or searching device, capable of exploring a space of possible forms. These abstract machines may be viewed as equipped with "knobs" controlling certain parameters which in turn define the dynamical state for the structure-generating process, and hence, the nature of the generated structures themselves. Key parameters include those controlling the strength and thoroughness of the sorting process and the degree of consolidation or reproductive isolation for the double-articulation machine; or the degrees of temperature, pressure, volume, speed, density, connectivity that play the role of control parameters generating the stable states in meshworks; or the rates of mutation and recombination which define the speed of the probe head, as well as the strength of biomass flow and of the coupling between coevolving species, which define the kind of space that the searching device explores.

Hence, using these abstract diagrams to represent what goes on in the BwO is equivalent to using a system of representation in terms of intensities, since it is ultimately the intensity of each parameter that determines the kind of dynamic involved, and hence, the character of the structures that are generated. Indeed, one way of picturing the BwO is as that "glacial" state of matter-energy-information which results from turning all these knobs to zero , that is, to the absolute minimum value of intensity, bringing all production of structured form to a halt:

"A BwO is made in such a way that it can be occupied, populated only by intensities. Only intensities pass and circulate. Still, the Bwo is not a scene, a place, or even a support upon which something comes to pass... It is not space, nor is it in space; it is matter that occupies space to a given degree -to the degree corresponding to the intensities produced. It is nonstratified, unformed, intense matter, the matrix of intensity, intensity=0 ... Production of the real as an intensive magnitude starting at zero." {19}

I must end now this brief exploration of what a Neo-Materialist interpretation of the philosophy of Deleuze and Guattari would be like. No doubt much detail has been left out. I like to think of my interpretation as a kind of "pidginization" of

their complex ideas, followed by a "creolization" along original lines. It nevertheless retains its basic geological spirit, a philosophical stance which rejects ideas of progress not only in human history but in natural history as well. Living creatures, according to this stance, are in no way "better" than rocks. Indeed, in a nonlinear world in which the same basic processes of self-organization take place in the mineral, organic and cultural spheres, perhaps rocks hold some of the keys to understand sedimentary humanity, igneous humanity and all their mixtures.

References:

{1} Herbert Simon. The Sciences of the Artificial. (MIT Press, 1994). p. 32-36

{2} Fernand Braudel. The Wheels of Commerce. (Harper and Row, New York, 1986). p. 28-47

For the idea that "invisible hand" economics simply assumes that demand and supply cancel each other out (i.e. that markets clear) without ever specifying the dynamics that lead to this state see:

Philip Mirowsky. More Heat than Light. Economics as Social Physics, Physics as Nature is Economics. (Cambridge University Press, New York 1991). p. 238-241

Mirowsky shows how the concept of the concept of the "invisible hand" was formalized in the nineteenth century by simply copying the form of equilibrium thermodynamics (Hence, in his opinion, this branch of physics provided more heat than light). He also warns that recent attempts to apply Prigogineis theories to economics are doing the same thing, for example, assuming the existence of attractors without specifying just what it is that is being dissipated (i.e. only energetically dissipative or "lossy" systems have attractors). See:

Philip Mirowsky. From Mandelbrot to Chaos in Economic Theory. In Southern Economic Journal. Vol. 57, October 1990). p. 302

{3} Gilles Deleuze and Felix Guattari. A Thousand Plateaus. (University of Minnesota Press, Minneapolis, 1987). p. 335

"Stating the distinction in its more general way, we could say that it is between stratified systems or systems of stratification on the one hand, and consistent, self-consistent aggregates on the other... There is a coded system of stratification whevever, horizontally, there are linear causalities between elements; and, vertically, hierarchies of order between groupings; and, holding it all together in depth, a succession of framing forms, each of which informs a

substance and in turn serves as a substance for another form. [e.g. the succession pebbles-sedimentary rocks-folded mountains, footnote#5 below]... On the other hand, we may speak of aggregates of consistency when instead of a regulated succession of forms-substances we are presented with consolidations of very heterogeneous elements, orders that have been short-circuited or even reverse causalities, and captures between materials and forces of a different nature... ".

{4} Harvey Blatt, Gerard Middleton, Raymond Murray. Origin of Sedimentary Rocks. (Prentice Hall, New Jersey, 1972). p.102 and 353

{5} Gilles Deleuze and Felix Guattari. A Thousand Plateaus. op. cit. p. 41

Actually, here Deleuze and Guattari incorrectly characterize the two articulations involved in rock-production as "sedimentation-folding". The correct sequence is "sedimentation-cementation". Then, at a different spatial scale , "cyclic sedimentary rock accumulation-folding into mountain". In other words, they collapse two different double-articulations (one utilizing as its starting point the products of the previous one), into one. I believe this correction does not affect their underlying argument, and that indeed, it strenghtens it.

{6} Niles Eldridge. Macroevolutionary Dynamics. Species, Niches and Adaptive Peaks. (MacGraw Hill, New York 1989). p. 127

{7} S.N. Eisenstadt. Continuities and Changes in Systems of Stratification. In Stability and Social Change. Bernard Barber and Alex Inkeles, eds. (Little Brown, Boston 1971). p. 65

{8} ibid. p 66-71

{9} Humberto R. Maturana and Francisco J. Varela. The Tree of Knowledge. The Biological Roots of Human Understanding. (Shambhala, Boston 1992). p. 47 and 115.

Other researchers have discovered that as the loop adds new nodes it may reach a critical threshold of complexity and undergo a bifurcation, a transition to a new state where complexification accelerates. Since the states to which a phase transition leads are in no way "directed" or "progressive", changing and developing by crossing bifurcations is another way of growing by drift.

{10} Ilya Prigogine and Isabelle Stengers. Order out of Chaos. op.cit.. p. 147

{11} Francisco J. Varela. Two Principles of Self-Organization. In Self-

Organization and Management of Social Sytems. H. Ulrich, G.J.B. Probst eds. (Springer Verlag, Berlin 1984) p. 27

{12} Gilles Deleuze and Felix Guattari. A Thousand Plateaus. op.cit. p.329

{13} Michael Bisacre. Encyclopedia of the Earthis Resources. (Exeter Books, New York 1984). p. 79

{14} Gilles Deleuze and Felix Guattari. ibid. p. 328

The authors constantly refer to catalysis in their theories of meshwork-like structures (rhizomes, smooth spaces etc.) They tend sometimes to view catalysis in terms on one specific (albeit very important) type of catalysts: the allosteric enzymes discovered by Jaques Monod, which are like programmable catalysts, with two heads:
"... what holds heterogeneities together without their ceasing to be heterogeneous ... are intercallary oscillations, synthesizers with a least two heads." ibid. 329

What is needed here is to make the notion of a "catalyst" more abstract so that the specific functions of a chemical catalyst (to perform acts of recognition via a lock and key mechanism, to accelerate or decelerate chemical reactions) are not what matters, but the more general notion of aiding growth "from within" or "from in-between". One step in this direction has been taken by Arthur Iberall (a pioneer in the application of ideas from nonlinear dynamics to human history), by defining catalytic activity as the ability to force a dynamical system from one attractor to another. In the case of a chemical catalyst the dynamical system would be the target molecule (the one to be catalyzed) and the two stable states would be its "unreactive" and "reactive" states, so that by switching them from one to another the catalyst accelerates the reaction. See:
Arthur Iberall and Harry Soodak. A Physics for Complex Systems. In Self-Organizing Systems. The Emergence of Order. Eugene Yates ed. (Plenum Press, New York 1987). p. 509

Elsewhere, Iberall notes that in this sense, nucleation events and dislocations may be considered to involve "acts of catalysis". Nucleation refers to the process through which the structures which appear after a phase transition (crystals just after the bifurcation to the solid state, for example) consolidate and grow, as opposed to reverting back to the previous state. (By crossing the bifurcation in the opposite direction). Typically, something has to catalyze the growth of structure to a critical mass (nucleation threshold) after which growth may proceed more or less spontaneously. This "something" may be anything from a dust particle to a defect in the container in which the crystallization is happening.

If one carefully removes all particles and defects one can indeed cool down a liquid past the bifurcation point without crystallization taking place. (Eventually, as we cool down further, even a microscopic thermal fluctuation can act as catalyst an trigger the nucleation). Dislocations , on the other hand, are line defects within the body of the growing crystals which help them grow by storing mechanical energy in their misaligned (hence nonequilibrium) composing atoms. This stored energy allows them to promote crystal growth by lowering nucleation thresholds. Thus, in this abstract sense of "catalysis" the intercallary events involved in the creation of igneous rocks are of the meshwork-generating type. On this see:

Arthur Iberall. Toward a General Science of Viable Systems. (McGrall-Hill, 1972). p. 208

But we can go further. Defined this way, "catalysis" becomes a true abstract operation: anything that switches a dynamical system (an interacting population of molecules, ants, humans or institutions) from one stable state to another is literally a catalyst in this sense. Hence, we may use this definition not only to move down from chemistry (the field of the literal application of the term) to physics without metaphor, but also up, to biology, sociology, linguistics. Cities and institutions, for example, would be instanciations of this operator to the extent that they arise form matter-energy flows and decision-making processes, but then react back on these flows and processes to constrain them in a variety of ways (stimulating them or inhibiting them). On the other hand, as Iberall himself notes, catalytic constraints may combine with one another and form language-like systems. Another physicist, Howard Pattee, has further elaborated the notion of enzymes (organic catalysts) as syntactical constraints, operating on a semantic world defined by its stable states.

On biological catalysts as syntactic constraints see:
Howard Pattee. Instabilities and Information in Biological Self-Organization. In Self-Organizing Systems. op. ed. p. 334

{15} Gregoire Nicolis and Ilya Prigogine. Exploring Complexity. (W.H. Freeman, New York 1989). p. 29

{16} Gilles Deleuze and Felix Guattari. ibid. p. 335

{17} Gilles Deleuze and Felix Guattari. A Thousand Plateaus. op. cit. p.159

{18} While the term "Body Without Organs" was first used in a philosophical context by Deleuze (borrowing from Artaud), the almost synonymous "machinic phylum" seems to have been coined and first used bt Guattari, in:

Felix Guattari. The Plane of Consistency. In Molecular Revolution. (Penguin Books, New York 1984). p. 120

I do not claim that the two terms are strictly synonymous (although I myself do use them that way). Rather what seems to be happening is that these philosophers instead of building one theory are attempting to create a meshwork of theories, that is, a set of partially overlapping theories. Hence, key (near synonymous) concepts (BWO, phylum, smooth space, rhizome) do not exactly coincide in meaning but are slightly displaced from one another to create this overlapping effect. The point remains that it is the referents of these labels that matter and not the labels themselves.

{19} ibid. p. 153