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The Dynamic Structural-Material Complexes of the Earth's Crust

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The Dynamic Structural-Material Complexes of the Earth's Crust

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Abstract: The self-similar dynamic structural-material complexes (SMC) from the composition of the Solar System over a period of about 4.5 billion years of the earth's crust, of the Earth's development under the conditions of self-organization are periodically formed. The synchronous or close-in-time series of genetically or paragenetically related igneous, ore-mineral, metasomatic, sedimentary formations, their structures and other processes accompanying them, the each complex (SMC) includes. Each complex in its formation is limited in time and space, according to the manifestation of the features of a spontaneous dynamic process; spreads in the volume of the Earth in a certain historical period; forms the composition and structure of the earth's crust at this stage, its polycyclic development determining. The number of cycles is about 14, with decreasing duration of their manifestation.

Keywords: lithosphere; earth's crust; structural material complexes; composition; structure; self-organization; polycyclic development

Introduction

The atmosphere, the mass volumes of the water basin of the world ocean and the solid Earth; the large segments in the lithosphere - oceanic and continental; their internal structure: the uplifts and the troughs, the mid-ocean ridges and the mountain folded belts, the rifts, the platforms; the systems of different geodynamic settings; the variety of the forms of geological bodies of the lithosphere and features of their placement, in the design of the geological bodies, their composition and age in the structure of the Earth, the asymmetric elements with a high degree of heterogeneity, exists. Such an asymmetry has a hierarchical character and, taking into account the elementary structure of matter, the chaotic nature of its internal content of the Earth determines. Questions about the structure and development of the earth's crust are being discussed [112,167]. At the same time, a high degree of order in the structure of the Earth and, especially, the lithosphere, is established. This is due to the dynamic features of the Earth's development [59–61].

Research methods

The levels of the hierarchy of organization matter in the series: the elementary particles – the nucleus – the atoms – the elements – the ions – the molecules – the minerals – rock (the formation), in the condition of the self-organization of composition geological substances, the accepted consideration determines. Their interaction [61–63], contributes to the manifestation of cyclic development [51-57, etc.]. An elementary, in the system of levels of the organization, the unit of geological and structural analysis is a rock (geological formations), how a characteristic of the features of the structure and of the Earth's development at a certain period of time. A geological formation, simply, formation, is a body of rock having a consistent set of physical characteristics that distinguishes it from adjacent bodies of rock, and which occupies a particular position in the space of rock in a geographical region, exposed. A unifying set of various synchronous geological formations, is the forms process which at this stage led to the forming of the earth's crust and lithosphere. Previously [51–54] a dynamic structural-material (formational) complex (SMC) of synchronous genetically or paragenetically related geological formations: igneous, ore-mineral, sedimentary, and metasomatic, to consider as the main geological structural unit proposed. This highest taxon in a number of levels of organization of matter, the process of formation of the earth's crust (continental and oceanic) at a certain stage its forms (SMC) fixes. SMC is identified with the metallogenic cycle of V.I. Smirnov [128] with some changes and details in terms of volume, content, and formation time. The contents of SMC are geological formations that make up mainly lateral rows of synchronous (close in time of formation within the cycle) formations and characterized by their variability and zoning depending on composition and genesis. The primary morphology of the volume occupied the geological formations and of the structure SMC, by the conditions of dissipation and fractalization determined. The SMC complete description can only be obtained with a global review, and in each specific region, with a different degree of locality, fragmentarily presented. The time range for the formation of SMC in space within the cycle is according to the actual data based on the study of the history of the geological development established. The genetic of geological formations SMC elements of all known geodynamic settings and structures of the Earth combines [4,140,163], which simultaneously manifest themselves laterally, Earth's crust forming. The SMC is a planetary structural-material unit – model, that manifests itself in different ways in certain parts of the planet of time in the period a given. The homodromic associations of endogenous formations of igneous rocks, which determine the age volume of the cycle SMC, ore-mineral, metasomatic and synchronous sedimentary formations, structural elements, various geophysical fields and phenomena associated are based [51–57,61–63]. The unified structural-material subdivision of the proposed for the features of the lithosphere and the earth's crust by determined a) material associations, their paragenetic and genetic relationships, sources of materials and features of formation; b) the dynamics of the formation of material associations and their placement in time and space; c) the time of formation of material associations and the frequency of their manifestation; d) the structure and morphology of material associations and the relationship of structure formation with their composition. Geological formations are distinguished according to the conditions of their genesis: magmatic (igneous), ore-mineral, sedimentary, and metasomatic [22,53]. Their own complexes united genetically or paragenetically formations forms each of them. Such substances as water and gas, for which formation affiliation is not used because of their special properties and state, but which play a crucial role in the processes, here as it should be also added. Water occupies a leading position in the hierarchy of the planet's matter; it is an integral element of living and part of non-living matter [46]. It volume of the seas, oceans, river network, and part of the atmosphere and lithosphere in the free state fills. Water binds as part of mineral associations [6] or is released during their physicochemical transformations [64], creating mineral waters, brines, and in the depths of magma chambers forming [90]. Water participates in the circulation of the Earth's crust and lithosphere [39], and is a part of the general dynamic process that creates hydrogeological conditions for its occurrence [150]. The second substance - gas also occupies an important place in the material structure of the Earth and its immediate and distant surroundings. Hydrogen, helium [23], carbon monoxide and dioxide, methane, nitrogen, radon, argon, and other gases, all of which, to one degree or another and in different quantities, are found in minerals, rocks, circulate freely through cracks and faults in the earth's crust and expire from the surface [5,135,137,138].

Research results.

All the diverse matter of the earth's crust in the form of geological formations is concentrated in the following synchronous complexes that compose it at a certain stage.

The complex of magmatic (igneous) formations of the Earth's crust

The igneous rocks of different compositions the synchronous genetically (or paragenetically) related over a certain period of time (cycle) combines. The large number and compositional diversity of specific igneous rocks [43,47,86,87,106], can be limited to formational petrochemical types presented [2,3,12,32,36,37,55,161]. The four classes of natural chemical compounds: ultrabasic (peridotite, komatiite, ophiolite), basic (gabbro - basalts), intermediate (diorite-andesite) and acidic (granite - rhyolite) with sodium, potassium or potassium-sodium bias of all igneous formations can

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be based [52–55,160]. The rocks of these classes are comparable to the igneous formations in the Earth's crust, practically among geological products of all ages established [54,72,73,116]. The most ancient formations of the earth's crust by ¾ are volcanogenic rocks, among which basic and ultrabasic ophiolites, metalavas, metatuffs, metatuffites by composition, metamorphosed to a high degree of facies, as well as igneous rocks of intermediate and felsic composition (lower archean, possibly catarchean) [1,12,41,42,54,93,94] are distinguished. The physicochemical evolution of the Earth by a change in the ratios of the content of various chemical elements and rock-forming oxides of abundant elements and all others - small, scattered, rare, radioactive periodically introductions are accompanied [61, 8, 152, 160, 164, 165, 168, etc.]. These processes were not equilibrium and took place in a complex dynamic environment, due to both the dynamics of physicochemical reactions and the influence of the surrounding dynamic environs and chambers fluctuating [1,10,14,27,34,35,41,42,47,58–62,65,79,85,86,88,102,104–106,130,131,147,157,166]. It can be concluded from a comparison of rocks and igneous formations of different petrochemical classes of the Earth's crust. The complex of igneous masses crystallization, their deformation, the presence of various impurities of accessory minerals, nanoparticles, and a large range of trace, rare and radioactive elements are manifested. Textural and structural features of igneous rocks a significant role in their formation of the dynamic process as a whole, similar to the segregation of silicate igneous melts of different composition shows. This whole process by the general vibration-wave, fluctuating state of the Earth's matter superimposed is [162]. The magmatic melts, of the Solar System composition mainly in the deep, subcrustal zones of the Earth - in the lower lithosphere, asthenosphere, and mantle with the participation of segregation processes origins. Their further self-organization possibly occurs at different deep levels of the lithosphere and the earth's crust, depending on P–T conditions, melt viscosity, migration routes, and, all in all, dynamic conditions [88,168]. A source for magmatic melts can be an inhomogeneous mantle substrate periodically activated in the depths of the Earth. Synchronous or close-in-time homodromous rock associations in the series ultramafic – mafic – medium and acidic crystallizes in the Earth's crust occur with their formations the organized [53,54,61–63,157,158]. The formations that make up a series are, as a rule, unequal in their quantitative ratios and space-separated, but conjugated associations are also in many cases found [44,65,79]. The continuous, discontinuous, and contrasting volcanic formations have been described, by alkaline ultrabasic and alkaline gabbroid-syenitic series while large slabs, terranes, and ancient blocks are also characterized [10]. The igneous rocks series ultrabasic - basic – medium – acidic is one-stage paragenetically and genetically related associations (formations) synchronously or close in time, arising in the earth's crust, can be combined into a single igneous complex at a certain stage of the Earth's development from a common Solar System composition substrate formed. The single igneous complex is by the volume of the substance that makes up its formations, and the time of organization by the age of the rocks included in it is determined. Magmatic complexes in the history of the Earth were periodically formed, forming the basis of the polycyclic structure of the earth's crust and lithosphere.

The complex of ore-mineral formations of the Earth's crust

The various mineral deposits of endogenous and exogenous origin in the earth's crust are known. The entire group of minerals, due to their material content and the peculiarities of the appearance conditions, also into the ore-mineral formations subdivided. The ore-mineral formations, as a rule, are complex in composition, ore and non-ore minerals associations (paragenesis) are composed. For the material associations the source different compositions and depths can be served. Most of the magmatic (plutonogenic), volcanogenic, and hydrothermal ore-mineral formations apparently have a mantle source of matter [13,19,27,48,50,100,115,130,153]. The bulk of stratiform type ore deposits occurring in sedimentary and metamorphic rocks are syngenetic and mixed origin, and the source of the ore matter from the deep mantle and due to the mobilization of crustal rocks and ore-bearing formations [66,123]. A significant group of diverse deposits of sedimentary and metamorphic origin has a syngenetic source of ore-mineral formation [29,44,101,119,129,130]. The possibility of a genetic relationship between endogenous ore deposits and igneous formations of

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different composition and facies [7,26,27,48,50,52,53,66,84,119] have shown many years of experience in geological observations, established empirical patterns, and experimental and theoretical studies having. For basic and ultrabasic igneous rocks, volcanogenic and volcano-plutonic formations, and rare-metal deposits associated with acidic rock granites, these relationships reliable are most. The common features of their course, the relationship between the redox conditions for the formation of igneous rocks and their ore content established, and the study of the physicochemical problems of magmatic and ore processes were revealed. A genetic connection between certain groups of ore deposits and certain series of igneous formations the possibility experimentally has been shown. The number of elements, for example, the tin, possibility of a genetic relationship in fluid-magmatic systems with both granitoid and basaltoid melts has been proved [75,78,80,82]. The possible partial miscibility fluid systems in silicate melts of different compositions this indicates [132]. The concept of the great importance of deep fluids in the selective smelting of melts and the generation of gas-liquid superheated solutions that can coexist at different levels and generate the corresponding mineral parageneses, more and more geological evidence, experimental data, and theoretical developments confirms [78,80,130]. The genesis of the ore-mineral formations the complex processes in the mantle and the heterogeneity of its composition, which led to the development of views on ore-magmatic (magmatic-ore) fluid systems are based, all available data on the geological manifestation of endogenous ore deposits this indicate [79,82,97]. The paragenetic and genetic relationships of heterogeneous mineralization with heterogeneous, but synchronous igneous formations identified, allows us to talk about paragenetic relationships of the same age (or close in age) mineralization, by deposits of different formational affiliation, represented. These deposits of mineral raw materials: iron, copper, nickel, platinum, molybdenum, tungsten, tin, lead, zinc, silver, gold, mercury, rare metals and earth, etc., all almost types are known. They are dispersed in space in accordance with the development and distribution of related igneous rocks, and in some cases complex multi-type, multi-metal deposits, but simultaneously or close to time are formed [52,53,56,119–122,128]. This the researchers to understand the possibility of not only the spatial combination of heterogeneous endogenous formations but also the synchronous, parallel manifestation of ore processes in the earth's crust led. The liquation, which is associated with the separation of fluid melt from parent magmas, which selectively concentrates ore-forming metals, the main contribution to the composition of ore matter in the course of magmatism is made by [88]. The selective segregation processes manifest themselves against the background of the development of the process of mantle activation, when, due to the inhomogeneous field of P –T conditions, igneous magmas are synchronously formed – melts of the homodromous series ultramafic-mafic-middle-acidic and the corresponding fluids-solutions most significant are ore-formed. The natural course of development of physicochemical conditions of vibration-wave non-equilibrium irreversible thermodynamics and structure formation under conditions of self-organization [61] obeying, their further paths in the earth's crust can diverge. The whole variety of endogenous ore manifestations of various formations during the development of the ultrabasic-basic-medium-acidic homodromous magmatism is a single complex of natural ore-mineral formations of the earth's crust in this period formed [62]. The systematization of ore formations due to the great complexity and uncertainty of many issues, has not been completed. V. M. Zeisler approached this issue most successfully and logically [146]. The names of ore-bearing formations by mineral specialization are determine. There are single-component and multi-component ore-mineral formations [53,56]. Mineral deposits of various formations that arise in the earth's crust, genetically or paragenetically associated with the igneous complex ultramafic - basic - medium and acid granitic, as well as coeval syngenetic ore-bearing formations, can be considered as a single ore-mineral complex of the earth's crust. Ore-mineral complexes throughout the history of the Earth [56,119,129], were formed periodically, emphasizing its polycyclic development.

The complex of the sedimentary formations of the Earth's crust

Sedimentary cover of the planet according to A. B. Ronov [117] is 80% on land and 76% on the ocean floor. The various geological formations depending on the formed conditions, among

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sedimentary rock are distinguished [9,57,87,113,136,145,146,149,155]. Three main groups: a) biogenic, chemogenomic, and halogenic; b) products of chemical degradation and destruction of earlier formations; c) precipitation of volcanic, water, atmospheric and space activities, are included. The geodynamic setting, geographic and climatic features, the regime of erosion, removal, and accumulation of material, and the composition of the sources of destruction and physical and chemical transformations, the characteristics of sedimentary formations primarily by are determined. Sandstones (95%), shales (80-85%), and limestones (18%) from the rest, the three main types of rocks are. The oceanic structures: shelf and continental slope, the largest volume of sedimentary rocks, and the diversity of formations are characteristic; less for plates and oceanic basins and much less for accretionary regions, intermontane and other types of troughs. The accumulation of sediments is the most continuous process, which is closely related to the processes of erosion, exhumation and the development of surface morpho-structures, relief origin within the continents, the bottom of the rivers, seas, and oceans, the destruction of matter is a natural part in the general of self-organization, which occurs immediately after its generation. The relief morphology and the composition of the emerging sedimentary formations paragenetically associated with deep geodynamic processes, since the latter predetermine the features are it. Since the processes of relief origin and oceans, geographical and climatic conditions on the globe are interconnected, a paragenetic dynamic relationship between the whole variety of synchronous sedimentary formations considered that there can be [57,83,95,98,114,126,133,134,154,156]. In fact, sedimentation is the ongoing rather spontaneous dynamic process of self-organization in the general history of the development of the Earth to create its structure this is. This relationship is more closely for conjugated drift and accumulation forms, where transitional mixed sedimentary formations and their series are formed outlined [31]. The sedimentary formations more often according to the material composition differences minerals paragenesis contains [83,101] and complex relationships with each other [139]. Many sedimentary formations are ore-bearing and syngenetic ore deposits contain [19,20,24,66,115,123], significant reserves of minerals: hard and brown coal, oil and gas, bauxites, placers of various minerals and metals, gold, phosphorite, fresh and mineral waters contains. For sediments rhythmicity, cyclicity, and periodicity are noted [30,43,96,133]. Accretion, the accumulation of sedimentary formations synchronously with the manifestation of magmatism and the formation of igneous rocks from the range of ultramafic - basic - diorites - granites and partly due to them and the destruction of more ancient exhumed rocks occurs. Mainly products of magmatism, manifested on the surface of continents or the bottom of the oceans suppliers also include. The sedimentation, exhumation to varying degrees, the morphostructures, and structural topography of the bottom of the seas, oceans, and the Earth's surface the processes of deep intrusive magmatism and the general dynamics indirectly contribute, features of its dynamic development creating. The set of sedimentary and ore-mineral syngenetic with them formations synchronous with the period of formation, corresponding to the igneous and ore-mineral complexes formed, by us as one sedimentary complex of the earth's crust in this certain period is considered. The periodic complexes of sedimentary formations throughout the continuous history of the Earth have been generated.

The complex of metasomatic formations of the Earth's crust

Metasomatic rocks in the earth's crust in connection with thermodynamic processes in a wide temperature and pressure range from deep magmatism, surface volcanism, gas-fluid, and hydrological activity, as well as the physicochemical regime of the geological environment and climatic conditions, are developed. We also include metamorphic rocks that are widely developed in the earth's crust, although the conditions and, especially, the scale of their manifestation are somewhat different. At the same time, both of them change in the primary composition under the influence of physicochemical conditions and processes are products. These formations are usually for each specific case with detailed studies of processes and phenomena and with areal mapping formational division carried out. The experience of classifying metasomatic formations in many works is presented [35,57,87]. Metamorphic rocks are characteristic mainly of pre-Middle Proterozoic geological formations. They occupy about 85% of the time interval of the planet's age and make up

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most of the earth's crust, possibly the lithosphere, and are exhumed into the upper horizons and onto the modern surface. These rocks are believed by the transformation of primary rocks of different origins and compositions, be formed, the nature of which is not always decipherable.The mechanism of this process is not entirely clear. Studies show that rocks in places that are not similar either in mineral and often chemical composition or in structural and textural features to their possible primary representatives are formed, about which we know almost nothing, except perhaps the elementary composition of the Earth. Of all the diversity of metamorphic rocks [35], the carbonate facies by the presence of marbles [136] and, in part, greenstone formation, similar in composition to ultrabasic and basic igneous rocks can most reliably be diagnosed [1,3,12,28,40,91]. They have been studied and described from different standpoints of composition, age, structure, and ore content [45,68–70,93,94,157]. The various formational groups among the metamorphic rocks are distinguished [87,106,146]. These groups of formations, depending on the degree of study, as part of the identified structural and material complexes of metamorphic rocks are described [93,94,104–106]. They are very complex in composition and structural, geodynamic, physicochemical, and age features are distinguished [11,153,157,164]. Three types are best known: greenstone, granulite and granite-gneiss belts. The greenstone belts, aged 1.6 to 3.9 Ga, are similar in composition to younger volcanic and sedimentary complexes. Granulite and granite-gneiss belts also formed periodically over a period of time from 1.8 to 3.7 billion years. On Earth, in different regions, about 7 cycles of their manifestation are noted. This triad: greenstone - granulite - granite-gneiss belts, presumably, to one structural-material cycle of the earth's crust can correspond. They include magmatic formations, mainly of basic and ultrabasic composition, gabbro-anorthosites, granulites, quartzites, conglomerates, calciphyres, and metasedimentary formations. Granite-gneiss belts by granites, granite-gneiss, quartzite-gneiss and other metamorphic, mostly salitic formations, are represented. Metamorphic formations cannot be combined into one common complex due to the long period of development and complexity. Various ore-minerals formations are associated with them.

Conclusions and discussion.

The dynamic structural - material complex of the earth's crust (SMC)

The synchronous formational of igneous, ore-mineral, metasomatic and sedimentary complexes, together with other phenomena and processes accompanying them in a certain period and forms a shell of the earth's crust of this period, is the combination of the above-described – SMC. The whole variety of geological processes to the dynamics of the material world in time and space is due [15–17]. The winged, figurative expression of V.I. Vernadsky: "... each grain of sand contains the entire periodic table ...", that all chemical elements are involved in all processes occurring on Earth, in quantities corresponding to their concentration and thermodynamic conditions is indicates. This manifests itself in various forms of geological movement, which on the vibration - wave mechanism of the dynamics of matter-substance and the theory of their self-organization in time and space, developed by the author [51–63,162] on the provisions in the works of I. Prigogine's schools [107–111] and G. Haken's [142–144] are based. The duration of the formation of individual phases of granitoid plutons, according to various estimates 10^4–10^8 years of geological observations, experimental data, and their analysis [34] is indicated. The time of formation of bodies of particular igneous formations is estimated differently from 2-3 million years to 5-10 million years, and gabbro-granite series - 100-200 million years, is estimated. A.G. Rublev [118] came to the conclusion that the period including the emplacement of magma, its crystallization, and deposition does not exceed 10–20 Ma. Time of formation of multiphase arrays - 20-30 million years; volcano-plutonic associations - 10-15 million years. The maximum duration of the act, the stage of magmatic activity at 40-50 million years is estimated. For formational analysis [87] similar figures are also given. For the formation of a deposit of a particular ore-formation the time is also different required. For plutonogenic, hydrothermal, and stratiform deposits, it is no more than 10^5–10^6 years [122,148]; in the case of polygenicity and polychromy, it is much longer [127,128], according to estimates (depending on the parameters and genesis). The deposit of sedimentary formations the duration is also different. Then it corresponds to

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geological periods and, on average, is about 55 million years [22], if we take into account the boundaries of the most intense rearrangements in the history of the Earth. About planetary geotectonic phases, the possibility of manifestation is discussed [52,53,69,73,81,103,133,134,139–141]. The periodicity and cyclicity of the development and formation of the earth's crust on the frequency of similar geological formations and their complexes, their age, and duration of formation, taking into account the main geotectonic boundaries, many researchers are recognized. From 5–7 to 17 and 22 subdivisions are distinguished depending on the principle of determining the boundary geodynamic, and structural boundaries [25,52–54,73,74]. The speed of geological processes is different [74], and the nature of the movement is oscillatory [89,92,99,141,167]. Different meanings and mechanisms of origin, however, many authors invest in this understanding. The Earth, from the moment of its inception to the present, is in a dynamic vibrational state of all its discrete elements and physical and chemical properties, which is the mechanism of its development as a self-organization open of the system, it seems to us [58–63]. The discreteness, scale invariance, and hierarchy of structural and material associations in the Earth’s crust [125,126], the formation of a multi-scale system of faults and cracks throughout space [38,151], and all other processes of the planet these features determine. In the earth's crust all known chemical elements are found. Some of them (about 50%) are in the native state, and some form molecular compounds (fullerenes, liquid crystals and supracrystalline compounds, minerals, brines, solutions, water and gases), are found. More than 6,000 mineral species, forming many rocks and rock groups are known. The various substances of the earth's crust, as the accuracy of determining the characteristic quantities, their closeness convergence depending on the total concentrations and thermodynamic conditions increases, analytical, chemical and physical studies, are shown. The complex heterogeneous structure of the lithosphere, their interrelation, and mutual conditionality, and the simultaneous occurrence of the whole variety of geological processes involved in its formation are more obvious, indicates. The cause-and-effect relationships of geological processes, their periodicity, synchronism, asynchrony, symmetry, asymmetry, globality, and locality, at the same time, a theory has not yet been created that would reveal their unified. The high generality of theoretical synthesis, which could be taken as the basis for constructing a general theory revealed empirical regularities have not been reached. Approaches for understanding general patterns in this regard, consideration of the problem of structural and material transformations in the earth's crust, and the search for the closest paragenesis in the environment of geological objects is of great importance, giving. At the same time, their interpretation in most cases, on empirical patterns is based. The deeper understanding of the state and development of the Earth as an open nonstationary dynamic physicochemical system, on the basis of new studies of the near space, the solar system, but mainly the development in the fields of physics, chemistry, and mathematics of theories of non-equilibrium, irreversible nonlinear thermodynamics, synergetics and fractality of dynamic systems, at the end of the last century, happened [58–63]. The three fundamental properties of the planet since its inception, are determined: 1) the exchange of energy and matter with the environment and the complex dynamic state of the planet and its matter; 2) self-organization, spontaneous irreversible development of all elements of its structure and matter in time and space, under conditions of non-equilibrium non-linear irreversible thermodynamics; 3) vibration-wave mechanism of synergetics of all geological processes and phenomena. The development of matter in nature under the conditions of vibration-wave spontaneous self-organization as hierarchical levels of its formation according to the scheme: elementary particles - nuclei - atoms - elements - compounds: ions, molecules, mineral, formation can be represented. Each of these levels by certain physical properties in time and structural space can be characterized. For the purposes of geological research, the most possible level of knowledge of matter and objects begins with chemical elements combined into various compounds that the whole variety of rocks of the earth's crust is made up of. The history of the Earth's development in the geological and structural analysis, it is advisable to use the formational consideration of material associations, according to the genetic basis at the same time, is studied. In the history of the development of the Earth to single out, as the highest taxon of the hierarchy of the level of organization of matter, a structural-material complex (SMC) of synchronous, or close in time formation, genetically (or paragenetically) related geological formations - igneous

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(formational complex), ore-mineral (formational complex), metasomatic (formational complex) and sedimentary (formational complex), based on the features of the theory of self-organization of nature, taking into account the above it is proposed [53,58–63]. In connection with the activation of the deep zones of the Earth in a certain period, the first three components of the complex (SMC) are of the same nature in the general thermodynamic process (cycle) are formed. The sedimentary formations synchronously with the latter, but represent the next phase of self-organization, due to their destruction, and more ancient and exhumed geological formations and other factors, but it also has a complex meaning, accumulate. Metasomatic and metamorphic formations are formed by the transformation of existing and earlier associations are formed. The Earth's crust over 4.5 billion years due to the periodic formation of the self-similar dynamic structural-material complexes described above, which determine its structure and polycyclic development has been formed. The number of such cycles – complexes (SMC) for the Earth's crust has not been established. During the pre-Middle Proterozoic period of history, there were at least 7 of them (cycles of the formation of the triad: greenschist, granulite, and granite-gneiss belts), and the same number in the Phanerozoic and up to modern times - 7 [52,63]. The development of the Earth's crust presumably, has 14 cycles there are. Each and every discrete element of the SMC structure to the average composition of the Solar System, the Earth, and the Earth’s crust is closed [167]. The structural-material complexes of the Earth's crust are a consequence of the vibrational-wave state of matter and spontaneous development in the field of its resonances of geological processes of self-organization in time and space under conditions of irreversible, nonlinear, non-equilibrium thermodynamics of open systems, which are formed. All elements are hierarchical, dissipative in nature, and fractal structure.

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