ONTOLOGY

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CRYOSOPHY IS THE ONTOLOGY OF COLD SUBSTANCE

SUMMARY. Amid realization of the cryosphere as a resource, source of goods and possibilities for mankind, but not a source of threat, a new philosophical trend in ontology called cryosophy seems to be a timely development. The essence of cryosophy is to understand the role of cold substance in the permanently changeable universe, to learn the cryosphere's basic properties and manifestations. The necessity of new ontological approaches is illustrated in the article by a number of up-to-date but hitherto not sufficiently discussed considerations regarding the cryosphere manifesting.

KEY WORDS. Cryosophy, cryosphere, ontology.

The turn of the century was marked in cryology — the science studying the cryosphere — with better understanding the object under research and a change in the research paradigm. The frozen state as a consequence of the cryosphere was accepted as "a very negative phenomenon from a practical point of view" since the moment cryopedology appeared in the first third of the 20th Century. Such evaluation, given by Koloskov P.I., can be found in the introduction to the book by Sumgin M.I. [1], one of the founders of cryopedology. This approach was more or less leading. The permanent fight with practical danger narrowed the subject under research and stimulated the search for technological solutions at the cost of furthering fundamental scientific knowledge. Only within the last decades has the attitude to the cryosphere as a universal phenomenon, the substantial-energetic staff of the Universe, the source of wealth and possibilities of human civilization and life on the planet, appeared and started to grow. This change of values caused changes in research methodology and, what is more important, a change in the subject outline and search vector.

Geneses of the cryology object

Within the last ten years the number of research structures studying the cryosphere has considerably increased. Great volumes of new scientific information that are sometimes difficult to followed up on make us conclude that cryology's object is expanding. At this moment, a broad panoramic view of the object, subject and methods of cryology is important, considering its interaction and cooperation with other sciences that may lead to a new philosophical trend of ontology —

cryosophy — appearing [2]. The essence of cryosophy is in scientific interdisciplinary understanding of place and the role of cold substance in the origin and evolution of material-energetic interaction in the universe, in creation of and sustaining life. Cryosophy is to study general essential characteristics and basic principles of the cryosphere in all its demonstrations and use both classical (while researching simple physical and chemical systems), synergetic (while researching something complex and alive) approaches and methods of information logistics producing knowledge about knowledge [3].

Simplifying the situation, it is possible to say that the key object of cryology is ice, its phase transit in particular. The temperature of ice-water phase transit under atmospheric pressure taken for the starting point of the Celcius and Remure scales is not accidental.

There are theories according to which ice is a simple side product of water transformation. They speak about three aggregate conditions of water but nobody can tell about three aggregate conditions of ice. Our subjective-specific perception of the world is evident, water is instinctively (and biologically) closer to us than ice.

The variety of conditions of water and ice are not comparable, ice has 17 phase conditions (11 of them are clearly seen) and water has only 1 phase condition. This variety is revealed in physical-chemical and biological processes, and even in such usual phenomenon as atmospheric precipitation: it rains with rain drops, it snows with snow of eight modifications and with two more combined water-ice types of precipitation.

Planetary ice can be defined as follows: ice — a chemical combination of basic elements of the planet's atmosphere's lower layers — is a solid substance transforming into a liquid or gas state under changing conditions and possessing, as a rule, a crystallized structure with micro- or macro-incorporations of liquids, gases and solid particles.

Ice combines opposite properties: a crystal is an amorphous body, elasticity — plasticity, semi-conductor — dielectric, lighter than water — possess the hardness of a steel knife. Ice has a vector of an ideal structure reach — under a constant low temperature the order measure increases with time, i.e. under a constant temperature the entropy decreases with time [4].

Only ice crystals are built with hydrogen links, i.e. ice can be considered the standard of hydrogen links. The same links play an important part in proteins, nucleic acids and biopolymers. Life owes its appearance to hydrogen links as all biochemical processes in a live organism are processes when hydrogen links are torn and then they appear again. Thus cryosophy can be defined as a system of philosophical knowledge about an object in which the measure is ice as a standard of bio-bone objects.

Hyperconsistency of the cryosphere

Since the first moment when the substance appeared from elementary particles such as protons, neutrons and electrons formed by a huge explosion, the Universe's evolution has been continuously connected with hydrogen and helium that were the first to appear in the process of cooling.

Hyperconsistency of the cryosphere results in the fact that the Universe's ice existed before the Solar system and its planets' appearance, before water and life's emersion on the Earth, and it will stay in the Universe even after the Sun's expansion

and heating up as well as the transformation of our planet into something like one of the lifeless hot planets. The Solar system cryosphere is a natural (and rather traditional in terms of methods) expansion of the cryology research object. Information on the cryosphere of planets and their compacts will be of practical importance in the mid-to near future.

The variety of conditions of planets and other big objects of the Solar system, their remoteness from the Sun, their trajectory character, the length of the year and the nycthemeron, the chemical composition, presence and composition of the atmosphere allow to look differently at the Earth's cryosphere. In this approach, it is accepted not as a unique object but as a typical phenomenon having exceptional bioprotective properties according to different circumstances.

It shouldn't be forgotten that the boundary of the Sun itself is rather relative, solar wind (the plasma radiated by the Sun) density is so high that territory near the Sun within the distance of at least 100 au from the Sun (heliosphere) can be considered as an equivalent of the planetary atmosphere. Thus the cryosphere of the Earth and other planets and their compacts is practically located in the cryosphere of the Sun (in this sense there are not only spots but ice as well on the Sun).

The last strides of cosmonautics based first of all on a sudden change in communication technologies revealed impressive cryogenic processes and phenomena on the Solar system's planets and their compacts. We are ready to see brighter pictures already. In their background the traditional object of cryology — the Earth's cryosphere does not look fascinating but it stays extremely important for mankind and all life on our planet.

The Earth's cryosphere

Defining the Earth's cryosphere as a hypersystem, the Earth's cryosphere stays in the place of a subsystem or a second-level system with its subsystems such as atmospheric negative-thermal multilevel layers with their peculiarities, cover components and lithospheric permafrost. But even this classical object of cryology should be naturally extended both geographically and in the sphere of temporal, energetic and special value.

Presence of the zone of depth solutions with phase passages makes us introduce into the conceptual construct of cryology conditions far out of the Earth's surface conditions and presence of undercooled water and ice (ice as a substance) at great depths [5], otherwise we limit the space related to the Earth's cryosphere when withdrawing from our subject the environment transformations obliged to cryogenic processes under different conditions. The deepest point of cryogenic processes and formations conditions intrusion known today is the depth of gas hydrates on the continents and in the oceans that create the positive-thermal cryolithozone expanding its dimensional boundaries.

It should be mentioned that the cryosphere is the most solid and instrumentally studied geosphere of the Earth from sea depths about 5 km up to Carman's line (the atmosphere and space boundary). No wonder, it's a habitat form of mankind. In spite of that modern scientific worldview, the knowledge system formed by a higher school of specialists-naturalists does not reasonably contain ideas on the influence of cryogen processes and phenomena upon the formation of the Earth's geological appearance and the creation of all life.

Cryosophy is a concept that conditions all living emergence

It's unquestionable that the presence of the atmosphere with its temperature screen aggregating water molecules and ice particles does not allow water to leave the Earth. This very factor was the key one for life to appear on our planet. All changes in the Earth's cryosphere influence the forming and evolution of the life support environment. As it is known, ozone appeared in the atmosphere 400 mil. years ago and only after that, life from the ocean stepped out onto the shore [6]. Born in the atmosphere, ozone tends to be distributed at a height similar to air distribution. A most important conclusion can be drawn out of that, i.e. all living organisms' emergence out of water and their separation from the Earth or free existence in the atmosphere (troposphere) is a result of the hydrogen bounding weakness.

The subject of our science is the transformation and interaction of prime elements from the first and the second wave: N and O. Their aggregation and the hydrogen bounding appearance are at the basis of a bony and living substance. Exploring the cryosphere, cryosophy can occupy its niche in concepts on the origin and evolution of life and living substance, if we take evolution sources out of the definite planet's frames.

According to Galimov E.M., life's appearance on Earth was preceded by the phase of pre-biological chemical evolution [7]. The hypothesis on selfsimilarity of crisis sequence in the history of civilization and the biosphere (historical time acceleration) [8] clearly seen within the period of 4 billion years of the Earth's history defines the moment of the galactic disc formation about 10 billion years ago as the starting point of pre-biological evolution. At this very time, practically at the moment of the galaxy's emergence, ice begins to appear as a phase suggesting samples of the molecular interaction for all life.

Much research into the origin of life is continued by works by Oparin-Choldein on chemical evolution, chemogenesis, the appearance of complex protein forms from simpler combinations. The academician Yushkin N. supposes that 'minerals might have served as catalysts for the emergence of more complex hydrogenes and pass the first molecules a part of their structure [9] in the sense of information and genetics'. The general idea given by Yushkin N. is that 'many biogenic and biological processes are defined for the whole of nature as basic processes of crystallization and formation of an ordered structure. Biological structures' formation turned out to be a substance transition on to a qualitatively new order level.'

The complexity of ice's inner structure and the peculiarities of its phase transitions, far from equilibrium conditions, are self-sufficient to form ordered synergetic behavior and the emergence of stable macroscopic objects. Not only classical snowflakes are spoken about but also water drops' ordered structures in atmospheric clouds [10]. Similar phenomena can appear to be that very missing link between bone and living substance.

It seems quite natural that the average annual temperature on Earth did not considerably deviate from the point of ice-water phase transition. Like water, ice has unique thermo-inertial properties which, in combination with their spread on the Earth's surface, allow the cryosphere to perform the function of a temperature stabilizer. In comparison: water's heating capacity is 5 times higher than soil's average heating capacity, and its volumetric heating capacity is 3300 times higher

than the air's heating capacity. So to heat 1 liter of water you will have to spend 3300 times more energy per 1°C than to heat 1 liter of the air. The high heating capacity of water and ice makes them the main accumulators of solar energy on the Earth.

But this is not all. The phase transition point itself has additional and also abnormal thermostability. The latent heat of ice melting is 5 times higher than that of gold, and 28 times higher than that of mercury (12). Thermal stability defines favorable conditions for all living emergence and development. Ice plays the role of a bio-protector and stabilizes the outer environment parameters.

Cryobiology research

The alliance of cryology with biology naturally suggested itself from the first years of official cryopedology in the USSR. Finds of mammoths, insects revived from permafrost thrilled minds in the first half of the 20th Century. Besides, civilized Europe did not experience the permafrost phenomenon because of one reason evident in the 19th Century, i.e. a forest can't grow on frosted soil. The recognition came from the great A. Humboldt and only after that permafrost acquired 'the right to exist' in European science.

Nowadays work on cryobiology can be read as science fiction: revived caterpillars, butterflies, i.e. highly organized creatures after a long period of freezing at up to -269°C, invertebrates such as rotifers, nematodes in dried condition stood deep freezing at up to -271°C. Thus life in frozen formations under natural circumstances is just an extreme kind of existence for microorganisms. As core samples from the Vostok station showed, nature preserved the temperature regime more accurately than a man providing fairness of cooling and heating for hundreds of years, that is what exactly is needed for adaptation. The thing our scientists have already got from the paleobiota is only a successful beginning and major discoveries remain to be made.

The target of cryobiology is to get preparations from permafrost to provide life quality [11]. Ice is a life environment or, to be more exact, is a co-evolving system with a stable imbalance, together with which microorganisms should be understood as an integral part of ice or another frozen substance. Together with biology, cryology is to cut a general road to understanding ice function in creating and sustaining life in the concept of a periodically disturbed Eldridge and Gold's balance. There are too many pluses that ice has in comparison with other environments. The physical properties are as follows: ice is a shelter from lethal radiation, it is a thermostat with minimal temperature gradients, it is a defense from chemical and biological mutagens, it is a constantly regenerating environment. Only the power of the microvolume friction inside ice is enough to make a film on water. It has already been told about hydrogen boundings of ice molecules which, by some accident, are the basis of boundings in proteins, RNA and DNA.

The cryosphere and society

The cryosphere has greatly influenced not only upon man's biology, but within the whole period of mankind's existence it also participated in forming social processes, beliefs, understanding the beautiful and defining people's world vision. According to Toynbee, not only civilizations' responses to the calls of the natural world are spoken about. It is not always when a 'cold', containing environment is a problem.

Many ethnicities have kept recollections on a far away and cold ancestral home, others have preserved myths and legends about mysterious and successful Hyperboreans. The notion of a comfortable life environment is relative, different for different kinds of living and for different cultural societies in different epochs. For many peoples, ice and snow are such a natural life environment, that they are accepted as a background, a natural condition of existence. Linguistics gives luminous proof of that.

Many northern peoples have hundreds of names for snow and ice, there are separate terms for lying or falling snow, a special term for river or sea ice, etc. but it is not the most important thing, in Russian there are about 1500 of the same words. The most important thing is that, for example, the Nenets have no notion of 'snow' at all, they have only words meaning its particular manifestations. Their civilization has not given birth to their own Aristotle, given a general, collective definition of any substance (in this case of frozen water). It should be remembered that Aristotle's 'substance' replaced among other principles Fales' 'water' as well. 2500 years have passed, and we following Fales write that the H_2O molecule is one of the first (if not the first) mineral in the Universe, however it appeared in the phase of ice but not water.

The historical fear of Europe for the minor Ice period (14^{th}-19^{th} Centuries) and bright impressions taken back from campaigns to Russia in 1812 and the 1940s influenced negatively the Europeans concerning cold perception. However, a healthy conservatism in European civilization, fear of global warming make mankind regard more carefully the Earth's polar thermostats. Mankind overcomes the culture of 'heat-centrism', 'cryo-phobia' and it is the most important step in overcoming other 'nature-phobias', a step to a tolerant culture, deeply ecological in its nature.

Taking into consideration everything that has been mentioned above, various conditions of ice can be presented on the following schematic (table 1) [12].

The emergence and functions of ice are formally systematized according to 6 hierarchies: 'Physical' system and 'Natural substance' (dimension scales), 'Physical-chemical' system and 'Phase condition' (energy scales), 'Information' and 'Managing' systems (time scales).

Two rows of the dimensional axis present the hierarchy of objects and environments in forming the properties in which ice plays an important role. The energy axis rows reflect the phase conditions of ice and its functional manifestations. On the time scale there are informational, resource and cybernetic manifestations of cryogenic systems: the change of characteristic times and speeds of processes, recording of information on the Earth's geospheres condition, synergetic processes, emergence and development of life.

Geology, cryology, cryosophy

Analogy is the most effective and probably the most ancient tool of learning. It is common for a man to experience the world by describing the unknown in terms of the understandable. Many traditional philosophies note the isomorphism of man and the world as well as micro- and macro-somes. In 1785 James Hatton, "the father" of modern geology, gave a supposition on the fact that the Earth is a super-alive organism having its own metabolic and respiratory systems that are fed by geological processes.

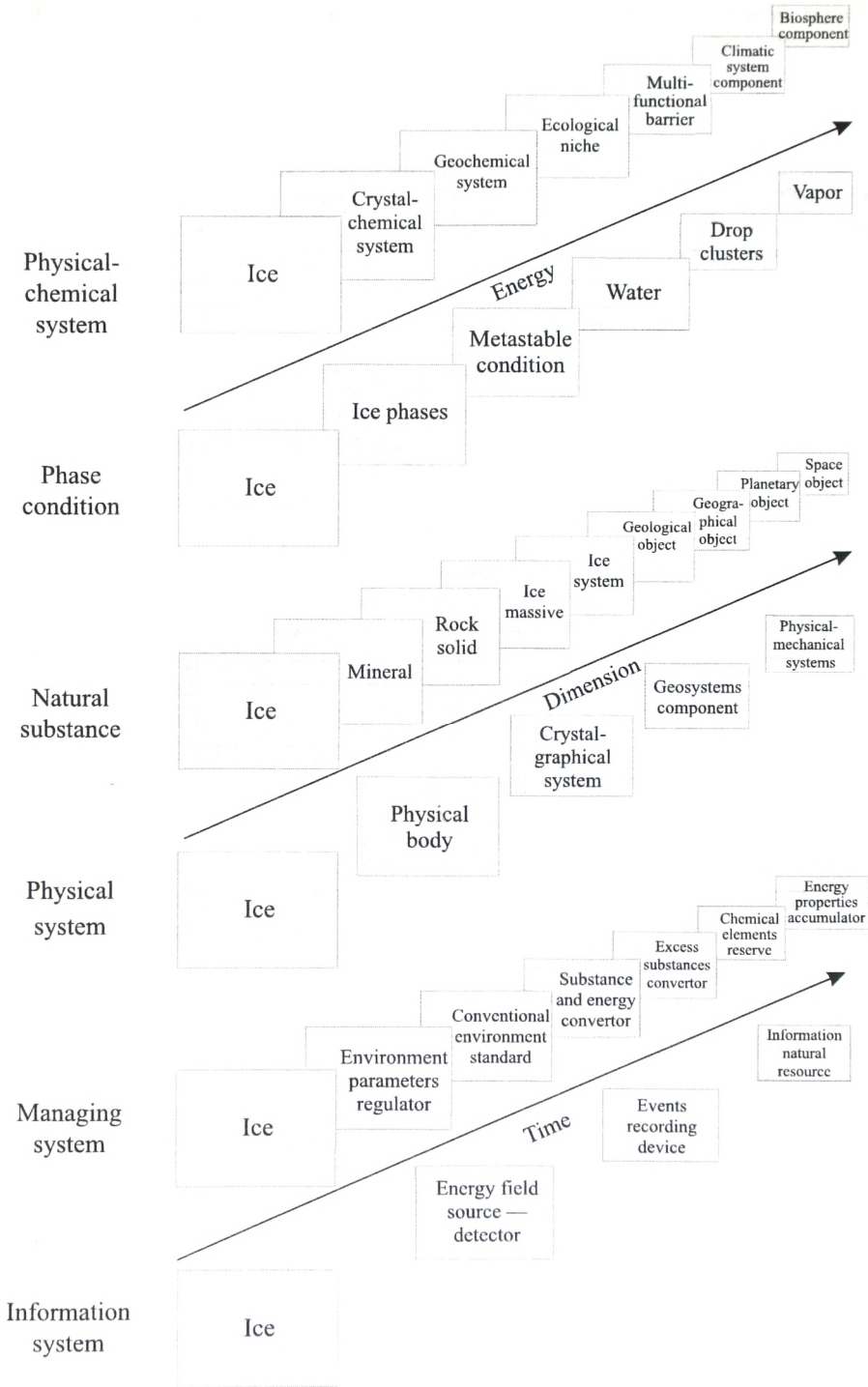

Table 1. Ice as a multi-functional system

Hatton's ideas and analogies were developed by Lovelock in his concept of Gay, according to which the Earth is a self-regulating system capable of keeping a comfortable climate and chemical composition for organisms living on it under different levels of energy coming from the Sun. Comparison of our planet to an organism is productive in the sense that the Earth and man are complex systems, have been rational for some time (the Earth has been rational since man's activity acquired planetary measures and became a geological power) and functioning in accordance with the principles of general systems theory.

Vladimir Vernadsky spoke about the exceptional role of a living substance in forming and regulating the Earth's geochemical environment parameters, and the physical characteristics of the biosphere, atmosphere and hydrosphere [13]. The cryosphere can claim a linking role in cooperation between life and the planet, for the part of the tool created all life first and then let the mind create comfortable conditions for life's existence.

The processes in which the key part is played by ice or water are variously closer to the point of phase transition, their manifestations are clearly seen and are often paradoxical. Various factors are brought to form a mosaic, the key to which is the affinity of ice and all life, their ability to form new complex objects, stable systems with new emergency properties.

Cryology uses such terms uncommon to traditional applied science as: variety, stability, complexity, emergency; systems are united into mega-systems, models are replaced by their hierarchies. All that gives it features of a post-nontraditional science, the main peculiarities of which are interdisciplinarity and topicality — targeting definite, current problems. In conditions of an avalanche-like expansion of the object and the subject of research, staying within the boundaries of the old narrow methodology geocryology will not be able to give satisfactory results.

At this moment, a moment of incredibly high paced knowledge growth and science co-penetration, of changes in education and role of the scientist in the society, cryosophy is to create the cryology image of the future — to expand its object, to offer a productive research methodology, to define prospects and expected results.

Cryosophy is to hold the attention, to make scientists get interested in a new approach to cryogenic processes and phenomena and to lead both traditional geocryologists and specialists of related branches traditionally busy with problems new for our society — biophysicists, biologists, planetologists and meteorologists — to scientific contact, to the 'short circuit' of the living and cold. Only then will they start thinking by categories of cryology, and project their conclusions on the sphere of cold, geocryologists will stop to 'discover' the phenomena and processes that have been known for ages with the delight of newcomers.

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