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ARCHAEOLOGICAL OBJECTS AS ELEMENTS OF INFORMATIONAL LIFE SUPPORT SYSTEM AND SOURCES OF INFORMATION ABOUT THE EVOLUTION OF THE ENVIRONMENT

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ABSTRACT: The article shows the objective criteria of sacralization of objects of natural and cultural heritage of Eastern Europe and Southern Siberia, based on the performance of informational function in ancient human life-support system (as instruments of navigation in space-time). Transformation of functions of sacral objects from their inception to the beginning of the third millennium, due to the development of geo-cultural space (changes in technology, socio-cultural paradigm and social and economic conditions). The stages of the evolution of navigation technologies, selected by the author on the basis of cultural layering of archaeological objects are reviewed in the article. The carried-out retrospective analysis allows to make the assumption that improvement of technologies of orientation could be a basis of emergence and development of *Homo sapiens* (sapientation): astronomical supervision in horizon observatory develops a system of ecological thinking; supervision over a shadow of the gnomon tool develops abstract thinking (the abstract graphic sign is genetically connected with concrete natural process)

Keywords: Navigation, Adaptation, Modeling, Technology, Evolution, Dating of natural disasters

1. INTRODUCTION

The navigation concept of information modeling of the world, developed by the author, explains the ancient sacred status of natural and cultural heritage by their important role in addressing the adaptation of the geographical challenges – namely in the development of geographical space-time. Application of methods of cultural geography and paleogeography, paleoastronomy and astroarcheology allows us to prove that these objects were created as orientation tools in space-time and provides the opportunity to "be at the right time in the right place," i.e. performed the informational function in life-support system [1]–[7].

Interdisciplinary studies of natural and cultural heritage of the Eastern Europe and Southern Siberia, conducted by the author in 2009-2015, together with a specialist in the field of archeology, culture, astronomy, showed that: 1. high degree of correlation of the dominant trends of the spatial structure of the ancient sacred objects with calendar azimuths of sunrise / sunset (and other astronomical reference points); 2. coincidence of these areas with the planned figure of the landscape; 3. reflection in the organization of sacred space (in the size of objects and the distances between them) of the system of ancient metrological standards.

The tradition of inheritance underlines the absolute importance of the position in geographic space, *its function in the intergenerational transfer of knowledge* – "comtinuity", and allows us to trace the development of navigation technologies.

2. OBJECTS AND METHODS OF RESEARCH

For the study were chosen representative archaeological sites (most typical and well studied by standard methods of the natural sciences and the humanities), revered to date: stone labyrinths of the White Sea, revered stones in the North-West Russia, the archaeological complex Divnogorie (Voronezh region), petroglyphs and megalithic complexes Gorny Altai, sacral complex Salbyksky valley (Khakassia), and others [8]–[12].

Field work, cartographic materials, aerial photos, satellite imagery and Google materials, scientific publications for the projects of natural and cultural heritage and the research problem were used to analyze the objects.

The applied methods of field of geographical studies (topographic, geological and geomorphological landscape and geomorphological survey), working with thematic maps and remote sensing data (landscape interpretation, selection and description of lineaments, planetary fracture systems, directions of outline structure of artificial and natural

facilities with the construction of diagrams of roses), standard laboratory analytical and statistical methods, the methods of the metrological analysis of archaeological objects and astronomical paleoastronomical calculations (altitude and azimuth position of the sun – with the help of astrocalculator, length and direction of the shadows – using basic trigonometric functions), as well as methods of mathematical, cartographic and conceptual modeling were used.

3. EVOLUTION OF TECHNOLOGIES

3.1 Analysis of Structure of Objects

Stability and continuity of the information function of natural and cultural heritage are proved by numerous examples of the combination of objects of different ages and modern geodetic network: in the North and North-West Russia – "landscape markers and halt points - stone labyrinths - geodetic points"; in Khakassia in "outrigger stele mound (ancient) - mound (later time) -geodesic point" and others. In spatial structure of the studied ancient objects azimuths by which dates of equinoxes and solstices are determined are revealed (Fig. 1-6).

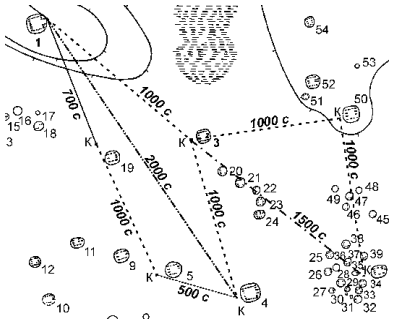

Fig. 1 The plan of a sacral complex in Salbykskaya valleys.

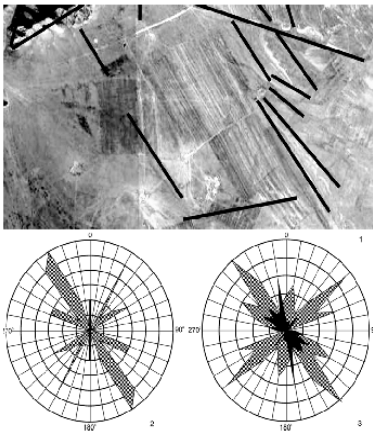

Fig. 2 Comparison of the azimuths measured between barrows and in a surrounding landscape.

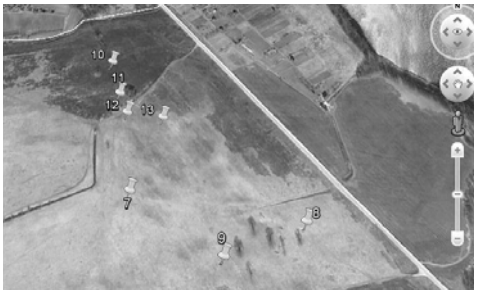

Fig. 3 Megalytic complex of the esteemed stone the St. Paraskev (Leningrad Region, lake Vrevo).

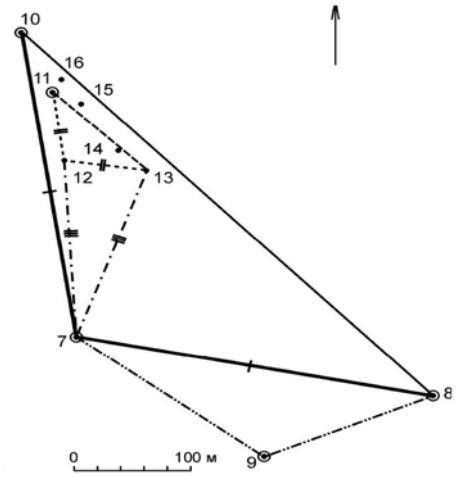

Fig. 4 Plan of a complex St. Paraskev.

Fig. 5 Stone labyrinth- gnomon of the White Sea.

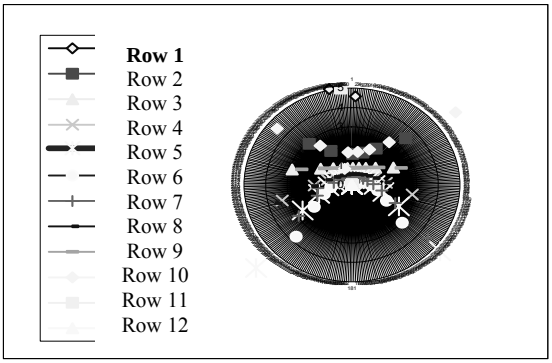

Fig. 6 The schedule of a shadow of a gnomon in a year. Row 1-12 – schedules of every month.

3.2 Main Stages of Evolution of Navigation Technologies

Based on the analysis of different age elements of sacral complexes, objectively there are five stages in the development of navigation technology: Landscape and megalithic (direct sight), megalithic (back sight), the historic stage of abstract modeling (development of a rational and creation of irrational symbolic), the current stage of the new navigation technology, communication and modeling.

3.2.1 Landscape stage of development of space-time

Landscape stage of development of space-time, the initial – describes the utilization of geographical space for fixing astronomical directions - space-time benchmarks. Foresight (observation), then check the sunrise / sunset at the solstices and equinoxes (and other astronomical targets) contribute to: 1. open and "rugged" horizon heterogeneity which allows us to record significant azimuths 2. lineaments – linear elements of tectonic structures, topography, linear borders of aquatic and territorial natural complexes. At this stage of development of orientation technology the landscape serves as astronomical instrument, and to keep the life-saving information the energy of natural processes, which indefinitely long maintain the spatial structure, is used.

To fulfill the information function of the landscape, since ancient times, with the economic zoning of the territory they received a special sacred status, the main feature of which is the minimum load in order to maintain the stability of the spatial structure. Thus, *the geographical criterion of sacralization of the landscape is a role in the life support system, which is determined by the need for human resources, information on the procedure of space-time.* This finding is consistent with the ethnographic data on the exclusive role of the revered natural objects in the pre-Christian traditions, dedicated to the Sun and the calendar.

The traditions of minimal impact on sacred landscape in the form of its labeling with stable to the destruction of cells or artificial additions (petroglyphs, petroglyphs on the rocks, the addition of rough stone –"obo", symbolic gifts in the form of ribbons or trophies fragments) are preserved. Shape and density of man-made additions into the sacred landscape orientation reflect the development of technology and especially the mentality, regional specificities, in particular, the availability of human activities in energy, raw materials and information resources, the demand for navigation information (social order).

Often, natural formations – erosional forms and remnants of weathering, associated with various forms of living beings. The issue of their natural or artificial origin is discussed, but on satellite images are easily determined azimuths of linear "chains" of stone objects, providing the definition of the astronomical seasons boundaries. Obvious possibilities of astronomical use of the natural and natural-artificial sculpture, based on their position in space, are an additional confirmation in the traditions and legends.

Determining the proportion of creative human participation in the formation of animal and anthropomorphic rock sculpture is simple enough: a comparison with neighboring geological and geomorphological complexes of similar genesis shows that the principle of the ancient architects was to "remove the excess." Apparently, this principle developed from the ancient taboo on the number of strokes taken on the stone to the quest for a perfect match to the living prototype (in classical sculpture). The wisdom of ancient technology, reflecting the mentality of "co-creation with nature", limiting the degree of change in the natural substrate, highlights the problems of modern interaction between human and nature as a bold violation of the natural forms of the earth's surface leads to a change, sometimes catastrophic, of water and air flow – those natural processes that remain the major sculptors of the planet.

The later artificially established megalithic sites can be considered as one of the stages of development of this tradition.

3.2.2 The second stage of development of navigation – megalithic

The second stage of development of navigation and information functions of the location of the sacred complex is megalithic, characterized by the use of artificial tools for foresight, fixing the hair lines of main astronomical azimuths and their relationship with the iconic elements of the landscape and visible objects on the horizon by a resistant to destruction and displacement of objects . The requirements of this technology meet the large-megaliths objects placed at a distance of a few hundred meters. Location of the horizon observatory is possible both on high, visually-related points of the relief, and in the valley – decrease, nearing the horizon, which makes landfill compact and relatively independent from the surrounding landscape changes. Exemplary embodiments of this technology can serve megalithical complexes of the Caucasus, the Kola Bay (megaliths city park plateau Sade and Crow stone in Murmansk) and others.

Even if the material of the megalithic complex was not subjected to significant relocations and processing, it should be seen as *artificial, natural and man-made*, because the process of creation of astronomical tools embedded knowledge and human labor. Different size and degree of treatment may indicate the value. One of nearly invisible, but conclusive evidence of artificial stone, or selection criteria, are measures, multiple units of the ancient system of measures – feet, elbows, fathoms. Metrological analysis is needed to define the distance between objects.

In Salbyksky Valley megalithic stage left behind the unique objects ("statuesque", complex "two stones", stone of fertility in the gate of the Grand Salbyksky mound), and the same type outrigger stele located on the west side near the largest burial mounds. Megalithic sites are the oldest in the valley, on the size, shape, quality and extent of the destruction of the stone, they are very different from the material used at a later time to build mounds. Similarly, in other regions – megalithic sites are the most ruined and slightly different from the natural elements of the landscape. So, seids are often perceived as typical "glacial boulders" and to understand "the structure due to function", a comprehensive eco-geographical and astronomical analysis is required, and for the definition of features of "architectural style" – a video, including local and regional variants (e.g., seids of Kola Peninsula, Siberia, North and South America).

At the landscape stage secure fit of astronomical directions was ensured by use of natural rock masses – the most resistant to tectonic movements and shifts under the influence of exogenous geomorphological processes (e.g., slope or cryogenic), at the megalithic stage, the *maximum non-mobility of artificially established monolithic sights was provided by their weight*, as weight determines the dynamics of objects. The gigantic sizes of buildings such as pyramids or temple complex of Baalbek were consistent with this task.

During the first two stages of astronomical observation people could see that horizon observatory after time unavoidably "lose their accuracy," not because of their design or underlying rocks are unstable, but due to the fact that the astronomical azimuths of celestial landmarks climaxes gradually changed, i.e., Space itself is dynamic. On the basis of accumulated knowledge it has become possible to calculate the long-period cycles and switching to more efficient, compact and precise technology, where the temple-observatory - is not just a tool, but it is a fixed point in space, the platform and data warehouse (calendar layout and markings).

3.2.3 The third stage is the backsight technology

Backsight has many embodiments, among which the most famous is path technology of fixation of shadow of the object and a focused beam. It is clear that the transition to monoinstrument – the gnomon of a sundial and the calendar took place gradually, through a series of intermediate options. For example, there are still a lot of megalithic sites, in which the shadow of one object to another object falls at sunrise / sunset (at least – of the Moon) on certain days of the year. In this case, the totality creates the functional integrity of forms – local astronomical and geodetic *network*. Two objects on the line W-E create the most simple form a network, which are linked by shadow twice a year – at the equinox, at sunrise and sunset. This approach revealed the solar calendar function in relief images of labyrinths in Galicia [13].

Observations of the shadow of the subject – the gnomon, not only at the beginning, but also throughout the light of the time of day, gives a person a lot more information – *measuring* horizontal and vertical angles, accurate clock and calendar *binding to the planetary system of coordinates* (latitude), the transition from local astronomical and geodetic network technology to create *regional networks*. The value of switching to navigation technologies of backsight emphasized in all cosmogonic myths, like the creation of the World from Chaos. As a rule, the myth explains the determination of the center of the world – axis, navel, etc., in other words, the center of a regional astronomical and geodetic network, the fixed position of Omphale.

Inclusion of objects into the regional network explains their position on the same latitude of other sacred objects. Thus, Divnogorie and Salbyk are located at the latitude of 51-52º, close to the latitude of Arkaim, Kiev and Stonehenge. This latitude corresponds to one of the boundaries of the seven climates, recorded in written sources of Ancient Babylon. At the latitude of St. Paraskeva there are: stone in the Pskov region, similar in structure and name, Shum-Gora (the largest mound in Europe, presumably – the tomb of Ryurik), Peryn (the ancient sanctuary on Lake Ilmen in the Novgorod neighborhood). The widespread development of local and regional networks provided toponymic marking of territorial navigation systems in space-time by the sun – the principles of a navigational markings developed on the historical geography of the works of V.I. Paranin [1], [2].

The largest number of heritage sites, performing the functions of a sundial-calendar, were revealed for the last 5000 years (labyrinths, stele, idols), perhaps because the older have not

survived or have not yet been investigated. The oldest archaeological finds are: Shigir idol – 11,000 years, the sundial of England and Turkey – 10,000 years, and others. The largest amount of solar labyrinth-calendars is concentrated in the Northern Europe. Calculations show that, at the southern orientation of the entrance to the labyrinth, its stone arcs serve as marks of the height of the midday sun, in other cases, the calendar information azimuths fixed entrance and all the spirals.

The biggest and most ancient cluster of stone labyrinths (Stone Age) is located on the island of Bolshoy Zayatsky, Solovetsky archipelago, and individual objects and images – on all continents except Antarctica. Labyrinths were built, as a rule, on the waterways, settlement sites, near freshwater sources. Examples of distance from the coast are not frequent, one of them – the labyrinth of the Bronze Age in Mostishche, 15 km from Divnogorie. Many labyrinth images were found on stone slabs in Dagestan.

An example of embodiment of a backsight technology is just a combination of "stone-tree", where the shadow of a tree falls on a stone at a certain hour. Tradition of honoring of the sacred stone and wood is preserved until recently in the Baltic regions and in Karelia.

The development of navigation is always accompanied by *the process of creating an iconic space-time equivalents and rational life-affirming symbols*. Undoubtedly, the foundation of sign systems is made on the basis of foresight. According to V.B. Frolov, the basis of the primitive graphics in the Old Stone Age was fused astronomical and mathematical knowledge. However, the most productive source of signs should be considered as the shadow of the gnomon, broadcasting navigational information in some regions almost continuously (in the conditions of the polar day). Analysis of the semiotics of light / shadow allows to reconstruct the information model of the world, which is different from the mytho-poetic model of humanities research that sets a measurable quantitative relationship between the natural process (lighting mode) and the spatial structure of cultural objects (layout structures and graphical basis of signs and images).

In general, the progress of technology of navigation of the first three phases expressed in improving the quality, while saving money and space requirements. As a result, *vitally important information about the space-time has been inherited, compressed in form and developed content*.

However, at the beginning of the Iron Age, in the conditions of the artificial urban environment, development of culture takes on a new - humanitarian direction. History tells us that the specific feature of the urban culture and the development of state forms of social order becomes progressive idealism and manipulation of knowledge, including the calendar systems.

3.2.4 Fourth - the historic step of abstract modeling

The historic step of abstract modeling is characterized by advances in navigation infrastructure of geo-cultural space, differentiation of features of tools (magnetic compass, water and hourglass), the development of abstract modeling world with the creation of rational – reflecting real natural processes and irrational characters – reflecting speculative build in the delimitation of the nature of cultural space (even if this limitation – wall laboratories and / or experimental conditions).

Technologies of navigation underlying the lunar-solar calendar, cease to be a priority for scientific and technological direction, falling back to more stable – distant landmarks of the sky of stars. The realization of the principle of the constructive role of the super-system of the universe with respect to the solar system finds its strain – Idealistic expression. There comes a stage of oblivion of achievements and transformation of meanings of the ancient culture based on solar navigation. Created at that time, the objects relate mainly to the cultural heritage category: palaces and religious complexes, but the navigation continues the tradition of binding object to create a space-time coordinates using the gnomon of the "laying" stone.

We know with what bitterness dominant religion eradicated the natural urban culture that has developed as the experience of hundreds of thousands of years: the baptism and enslavement of Rus, the Inquisition – In Western Europe. However, the traditions associated with the life support are very stable. In Christianity, for example, everything that could not be destroyed, was lit and left there under a new – Christian name. In this case, objects that once served as tools to ensure the real nature, according to the order of social life in the new system could save only a formal function - to maintain the tradition of ancestor worship and allow *symbolic treatment to universals of Time* (maintenance of health, prolong life, and the good childbirth – motives of reverence stone, extant). About the former connection to sight and eye, it resembles only water uses from these stone buckets "to improve vision". For example, St. Paraskeva stone and water were endowed with a therapeutic features that help in the treatment of eye and childbirth.

3.2.5 Fifth - the current stage of the latest technology

The current stage of the latest technology, characterized in that the ways of orientation, based on the achievements of the space, computer equipment, development of remote sensing data and communication systems develop actively.

In the era of the dictates of the world market and imposed on them by the state, mass consumer culture, the origins of modern culture forgotten objects of natural and cultural heritage of the veneration of objects are transformed into recreational resources (tourism) and other commercial activity (a wide range of health and magical practices).

Today, numerous examples can prove that almost all the heritage sites are focused and related to the calendar. However, the success of astroarchaeological and paleoastronomical studies (e.g., decoding of astronomical features of Stonehenge or the pyramids of Egypt) receives essentially idealistic interpretation – considered in the context of the local activities of the cult character. This line of thought obviously inherits practices and ideological direction, formed at the stage of the merger of church and state. It affects the same lack of scientific methodology, based on the laws of natural diversity, the weak development of methods aimed at identifying cause-and-effect relationship, the traditional art criticism for humanities research focus.

A variety of scientific methods used for navigational objects historic and prehistoric past, involves interdisciplinary cooperation with a view to the mutual enrichment of Sciences and the formation of multifaceted conception of the problem of natural and cultural heritage [1]–[15].

Modern science and engineering technologies enable the broad scientific research of the navigational designation of ancient objects. Geographical information system analysis of primary navigation purpose of sacred objects of nature and culture shows that objects are unique and their technologies are versatile, as technologies reflect the laws of the structure and functioning of the geographic space-time, and record the individual objects unique combination of geography at every point. The collection of iconic qualities of the landscape, representing the real basis of science and practice, become an integral part of the content of sacred geography, semiotics of geographical space and geography culture. Interdisciplinary studies of natural and cultural heritage in the geography will ensure the conservation status of objects, the correct definition of their composition, structure and boundaries, the rational use for tourism and recreation.

4. THE TRACES OF NATURAL DISASTERS IN THE STRUCTURE OF ARCHAEOLOGICAL SITES

Ancient objects retain in their structure not only landmarks of space and time, specific to each point the Earth surface, but also traces of destruction, forced by natural processes and social conflicts (including socio-cultural paradigm shift).

Natural disasters attract the attention of researchers due to the huge damage they cause and the possibility of their recurrence. Natural disasters are well distinguished from anthropogenic disturbances by the nature of changes (orientation, location, scale) and coverage area.

Archaeological sites are important to assess the strength and effects of catastrophic natural phenomena, since they can be explored by the quantitative methods to simulate causes and destruction mechanisms, to date the events, attracting both natural sciences (paleo-astronomical, anthropological, radiocarbon, geomorphological, geochemical) and humanitarian methods (comparative cultural analysis, historical evidence, non-written sources - the legends, etc.) [16]–[17].

4.1 The typology of catastrophic disturbances of ancient objects

Catastrophic (from ancient Greek καταστροφή "coup, overthrow, death") is called the fundamental restructuring of systems associated with the loss of their quality. Natural disasters, or catastrophes, can be divided by origin – their relationship with the processes in the main geospheres of the geographical envelope of the earth: in the lithosphere – volcanism and earthquakes (including the tsunami and the collapse of shores); hydrosphere – transgression / regression of reservoirs (flooding, draining coasts); in the atmosphere – cooling and climate aridity; in bio-sphere – a sharp reduction in the number and total disappearance of species.

Analysis of the impact of natural disasters on the structure of archaeological sites shows that, if the complete transformation of physical surface of the earth does not happen due volcano explosion or flushing by mud-rock flow, the structure of the anthropogenic objects is preserved in whole or in part (foundations of buildings, other sub-terrestrial and aerial parts). In this case, it is always possible to select the elements, created by humans (organized functionally) and traces of violations (oriented in the direction of natural flow).

The ratio of elements created by humans and devastating natural process can be different: 1. prevalence of undisturbed structures; 2. prevalence of damaged structures. On this basis it is possible

to obtain information about the direction and strength of catastrophic events, calculate the location of the epicenter, evaluate the area of distribution.

An overview shows that the majority of natural disasters do not lead to considerable momentary destruction of objects (e.g. extinction of species). In this case, the main factor of destruction is time.

Table 1 Type of catastrophe and forms of preservation of objects

Geosphere	Type of catastrophe	Forms of preservation of objects
Lithosphere	Volcanism, earthquakes (the collapse of the coast, the tsunami); slope processes (mudflows, landslides, etc.)	Buried under the rubble, ash and other natural materials; the remnants of foundations, artificial forms of relief (mounds, terraces, platforms)
Hydrosphere	Transgression, regression, change of direction flow, groundwater lowering	Immersion to the bottom; desolation as a result of flooding or severe water stress.
Atmosphere	Cooling, aridity, high winds, dust storms	The desolation of the landscape in the face of declining productivity; partial destruction of the bulk material and skid
Biosphere	Extinction of species as a result of changes in environmental conditions	The desolation of the landscape in the face of declining productivity.

4.2 The dating of natural disasters on the basis of paleo-astronomical analysis of artificial objects

Examples of studies of natural disasters by traditional archaeological methods are well known: the Pompeii excavations allow us to estimate the scale of the eruption of Vesuvius, the islands of Greece research reveals the details of the catastrophe associated with the explosion of the volcano of Santorini. A lot of information enables the work of underwater archaeologists in the areas land flooding. At the same time, the possibility of paleo-astronomical analysis is still under-utilized, due to: weak elaborate method; insufficient number of specialists; arts education of professional archaeologists.

The principle of using astronomical data embedded in planigraphy of ancient objects is simple and objective. Just as hands of a stopped clock – witness the last moments of life, "time stands still" and in place of the natural disaster, leading to death or relocation of the masses of people. This "stop" means the fact that the navigation technology in the region was devastated by natural disaster, ceases to grow, and astronomical instruments are tuned to the planetary-cosmic realities that exist in the real-time of their creation and operation.

4.3 Analysis of the transformation of the natural environment on the basis of archaeological sites

The use of features of astronomical navigation has the advantage that each point in the geographical area has its "astronomical binding". Therefore, creation of a database can be the basis for consideration of events of nature and culture in the system.

In the course of research, we have developed an algorithm of interdisciplinary research complex, which is consistently implementing the action, aimed to determine the functional connection of elements of natural and cultural complex with each other, the surrounding geography and outer space: 1. object of the study by standard techniques (measurement, description, comparison, metrological analysis - correlation with the ancient system of measures); 2. characteristics of the landscape (including the evolution of the climatic conditions during the Holocene, the analysis of the dominant systems in fractured rocks and lineaments directions); 3. astronomical and calendar calculations of paleo-astronomical azimuths of sunrise / sunsets and the moon, the height of the gnomon of a sundial-calendar and regulations of midday shade by seasons (for geographical coordinates of the object, taking into account the differences in physical and astronomical horizon); 4. establishment of the correlations of the spatial characteristics of the object, of the landscape and astronomical figures recorded at this point; 5. comparison of tool features of the object with local and regional life support tasks in different historical era (including the location of the object in the analysis of the transport communications system); 6. determination of the structure of violations related to natural disasters.

5. CONCLUSION

The spatial structure of the sacred (revered) objects of natural and cultural heritage provides opportunities for instrumental astronomical orientation in space-time. Cultural layering of

sacred archaeological sites allows to study forms of inheritance and to identify stages in the development of navigation technologies.

Development of instrumental navigation is connected with development of the abstract thinking and intelligence. The golden age of technology of fore sight can be correlated to appearance of the Homo sapiens and the Stone Age, and broad application of a gnomon – to a metal era (about 7000 years ago).

When dating ancient objects it is necessary to consider speeds of change of rocks and a relief of regions of Earth for the last 2000000 years.

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