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NATURE OF PARTICULAR STRUCTURE POSITION OF THE ANTARCTICA

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Summary. Two specific structural features are typical for the Antarctica continent. These are its position in the South Pole area with strong symmetry relatively the Arctic Ocean, and a system of the oceanic ridges forming a ring around Antarctica with regular sprigs of mid-oceanic ridges. The origin of these regular structures is difficult to conform to chaotic movement of the lithosphere plates but it may be explained by the fluids-rotation conception proposed by the author. The conception supposes two main energy sources of the global tectonics: the degasification of the Earth (the fluids advection) and changes in the Earth rotation. Three basic stages of the tectonosphere formation are distinguished by the conception. Judging by the paleomagnetic data in Archean-Proterozoi several blocks of thick continental lithosphere were formed in the southern hemisphere. Geochemical studies show that the continental lithosphere was formed in from the mantle matter with large contents of fluids and it means that the intensive deep fluid flow has been at that time in the southern hemisphere. The formation of the thick lithosphere has led to asymmetry of a planet and to the relative displacement of the mass centers of the Earth's spheres. That resulted in turning of the mantle around the core in Paleozoic with movement of the continental hemisphere to the north. Rotation of the mantle around the core created a new no equilibrium system. Therefore in Mesozoic era an expansion of the southern hemisphere began. Such expansion created the regular system of the mid-oceanic ridges forming a ring around Antarctica. Supposedly at the last stage the formation of the Antarctica continent on South Pole and destruction of a continental crust on the northern hemisphere (formation of the Arctic Ocean) took place to mount on the mass center balance.

Key words: Antarctica, mid-oceanic ridges, lithosphere, mantle rotation.

Реферат. Две специфические структурные особенности характерны для континента Антарктида. Это – его положение на Южном полюсе, строго симметричное относительно Арктического океана, и наличие окружающего континент кольца океанических рифтов с ответвляющимися от него срединно-океаническими хребтами. Формирование этих регулярных структурных особенностей трудно согласовать с хаотичным движением литосферных плит, но достаточно строго может быть описано с позиций предложенной автором ротационно-флюидной концепции. По этой концепции существуют два главных источника энергии глобальной геодинамики: дегазация Земли (флюидная адвекция) и изменения в характере вращения Земли. Выделяются три основные стадии развития тектоносферы. В архее и протерозое несколько крупных континентов сформировалось по палеомагнитным данным в Южном полушарии. По геохимических данным известно, что формирование континентальной литосферы происходит из мантийного вещества, насыщенного флюидами, следовательно, в это время максимальный поток глубинных флюидов был в Южном полушарии. Образование мощной континентальной литосферы должно было привести к асимметрии планеты и к относительному смещению центров масс земных сфер. Для восстановления равновесия в палеозое началось вращение мантии вокруг ядра и перемещение континентальных масс на север. Но это перемещение создало новую неравновесную систему. В результате в мезозое началось расширение Южного полушария. Это расширение привело к формированию регулярной системы срединно-океанических хребтов, образующих кольцо вокруг Антарктиды. На последней стадии развития восстановление баланса масс осуществляется за счет роста континента Антарктиды в южном полушарии и разрушения земной коры Арктики.

Ключевые слова: Антарктика, срединно-океанические хребты, литосфера, вращение мантии.

1. Introduction

The brightest distinctive feature of Antarctica is its position on the South Pole, strictly symmetric relatively to the Arctic region. The Arctic Ocean and the Antarctic continent are surprisingly similar both in size, and on general outlines, but are opposite in relief form and in earth's crust structure. The crust of Antarctica is more than 30 km thickness and has a thick (up to 10 km) granite-gneissic layer with the average seismic velocity of about 6.0 km/s. The earth's crust in oceanic basins of the Arctic regions is thin (about 5-10 km) and it has a high seismic velocity (6.5 km/s). As well as the other continents, the Antarctica is characterized by a thick lithosphere which is marked by the positive anomaly of seismic velocities (Fig. 1). This anomaly reaches the depth of 250 km. In the Arctic region, as well as under the other oceans, the negative anomaly is observed in seismic tomography sections.

Another distinctive feature of the Antarctica is the oceanic rift ring surrounding the continent, with the mid-oceanic ridges branching along meridians with approximately identical distance of 90° between them (Fig. 2). Three of these rift zones are traced in the southern hemisphere as the mid-oceanic ridges and traced further in the continental areas up to the Arctic regions, as tectonic active zones. The fourth zone spreads on the meridian 155° from the western margins of the Australian shelf and Philippine Sea up to the Sakhalin Island. Now these zones are defined as a zone of active hydrogen degassing (Sivorotkin, 2002).

A prominent feature of the Antarctic rift ring is the absence of the corresponding subduction zones: all surrounding continents have passive margins (Fig. 2).

All this allows to assume, that the marked structural regularity was created during the general development of the Earth as a planet. It shows that there was no large chaotic moving of separate parts of the tectonosphere relative to each other. It means that the formation of modern structure of the southern hemisphere cannot be explained in terms of the plate tectonics.

But it can be described from the point of view of the fluid-rotation concept (Pavlenkova, 2005).

2. The main principles of the fluid-rotation concept

According the fluid-rotation concept the large structures of the Earth's upper spheres were formed during the planet development because its initial heterogeneity. While the core and certain spheres were formed, the Earth's radius was changing; at that time the global system of rift zones, including the Pacific ring, was framed.

The basic sources of the global tectonic transformations according to this concept are degassing of the Earth (fluid advection) and changes in the rotation of the Earth or its spheres in system of the Earth-Moon-Sun. The essential role by degassing in global tectonics can be explained by the main feature that distinguished the Earth from other planets, that is the large contents of fluids, mainly hydrogen and helium, in its core (Larin, 1975; Gilat, Vol, 2005). No other kind of the Earth internal energy (convection, advection of deep matter and other) can be compared to fluid advection in the amount of transferable energy and in its rather small losses at long transportation. No other energy sources can provide such fast processes, as formation asthenolites, activization of the tectonic processes in local areas and in a short period of time, and seismic stratification of continental lithosphere. It is a constantly allocated and almost unlimited energy possessing high concentration and the high velocity of realization.

The Earth degassing has resulted not only in formation of the atmosphere and hydrosphere, the deep fluids also played an important role in the formation of the continental lithosphere. Continents and oceans differ essentially the lithosphere structure: in the oceans it is thin and low velocity, the continents have thick and high-velocity lithosphere (Fig. 1). On the data (Luts, 1980) the continental crust was formed from the mantle matter saturated with fluids, that is in the field of high intensive fluid flows.

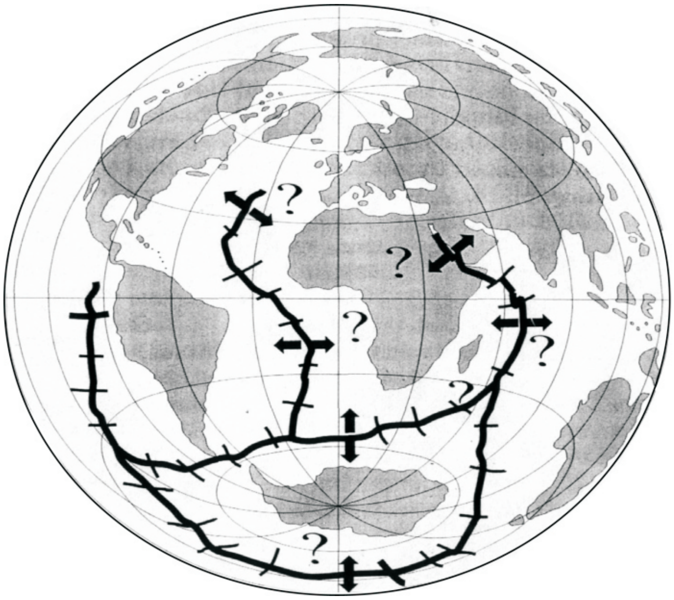

Fig.1. Tomographic cross-section of the upper mantle from the Arctic to the Antarctica. The section shows the seismic velocity deviation from the global model IASP91 in the percents. The earthquakes used for the section construction are shown by the points in the upper figure (Gossler, Kind, 1996).

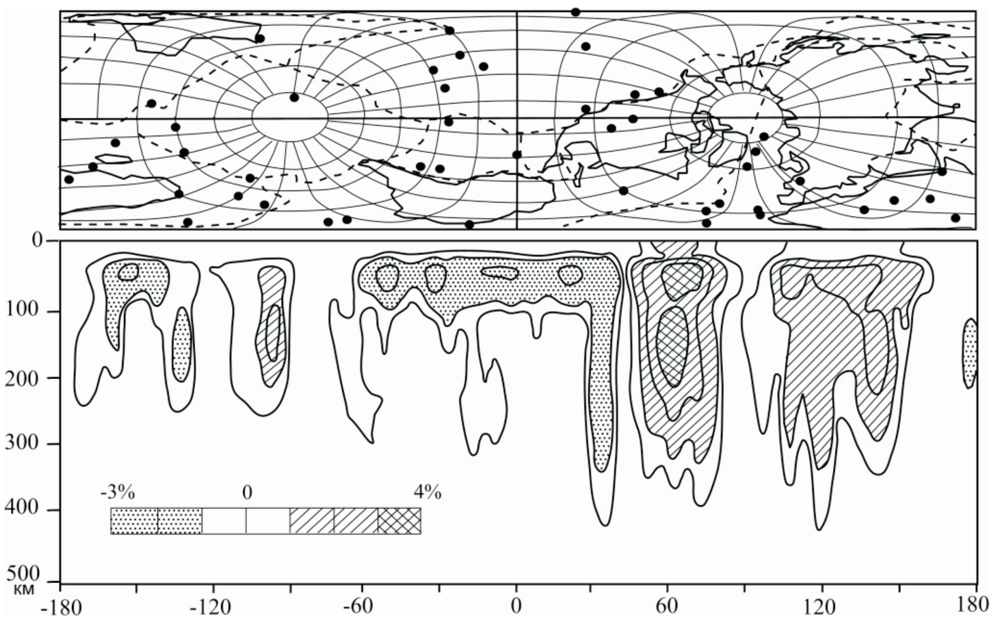

Fig.2. Scheme of mid-oceanic ridges which form a regular ring around the Antarctica and has no corresponding subduction zones around the nearest continents (Storetvedt, 1997).

The fluid flows also contribute essentially to the formation of the continental lithosphere. F.A.Letnikov (2000) has shown, that the long process of fluids carrying out should lead to the mantle matter changes and their crystallization. The longer this process proceeds, the thicker earth's crust and the whole lithosphere become. The further gradual cooling makes the crust more stable, promoting formation of the lithosphere less permeable in comparison with the oceanic areas.

As a whole, formation of continents can be presented as follows. First the Earth was covered with a thick and low density crust similar to the Moon crust (Marakushev, 1999). Then in the areas of intensive fluid flow the nucleus of the future continents with sialic crust and thick lithosphere were formed. In the place of the modern oceans where the fluid flow was weak, the primary crust kept its place and only separate blocks of the intermediate crust were formed. Its fragments are found now in all oceans.

The further formation of a continental crust was due to two basic processes: the growth of the crustal thickness and its granitisation. When the thickness reaches a certain level (now for platform areas it is 40-50 km), a plastic, low permeable layer is formed in its bottom. This layer prevents the crust from being destroyed by the mantle melts. The granitisation passes in conditions of the increased deep fluid flow which provide the additional energy necessary for the process. This process is important for the formation of continents because granitisation raises the stability of the rocks relatively various geochemical influences and protects the continental crust from destruction.

Another important feature of the tectonosphere structure is its regular spatial symmetry. The main law is the division of the Earth into two hemispheres with lowered surface (the Pacific Ocean) and with the higher relief (a continental hemisphere). This division into essentially different hemispheres is confirmed also by the data on different age, geological history and crustal structure in the Pacific in comparison with other oceans. It is not a casual feature of the Earth, the same structure is typical of the other planets, for example, the Moon and Mars, where the hemispheres with the prevailing raised and lowered relief are also allocated. All this indicates that there exist some general laws of the planet formation.

The formation in one hemisphere of large blocks of the continental lithosphere the thickness of which can reach 350 km, should lead to the infringement of the Earth's upper spheres balance. The balance restoration in the rotating Earth could occur by horizontal moving of the formed inhomogeneities. According to paleomagnetic data such moving really occurs. It is on this basis that the lithosphere plate tectonic was founded. But large and chaotic moving of the plates is difficult to bring into accordance with the regularity in the tectonosphere structure: its division into two hemispheres, symmetric system of mid-oceanic ridges and other. The large moving of the lithosphere plates will not be coordinated to the structure of the upper mantle. According to the seismological and seismic data (Dziewonski, Anderson, 1984; Gossler and Kind, 1996) under all continents the large seismic velocity anomalies covering the whole upper mantle are observed (Fig. 1). If the continents moved, they should have moved together with the upper mantle.

According to the rotation-fluid concept the continental lithosphere moving occurs due to the displacement of the mantle around the core. The theoretical data on the opportunity of such movements are ambiguous. It is usually considered, that tidal forces, taking into account the tectonosphere isostasy, cannot cause such large scale moving. However, in J.N.Avsjuk's (1996) and J.V.Barkin's (2002) papers such opportunity is not excluded. J.V.Barkin marked, that the centers of gravity masses of the Earth spheres are displaced relative to each other because of their heterogeneity and consequently possess at the significant dynamic compression. The Moon gravitational influence informs various acceleration to environments of the Earth, which results in an additional directed pressure between them. This pressure exceeds the tidal powers by three orders and can lead to the planetary reorganizations characterized with cyclicity, polarity, symmetry and inversion. In particular, it leads to the asymmetry of the Earth surface marked above.

The rotation-fluid concept of global geodynamics makes it possible to explain the present formation of the modern Antarctic region structure.

3. History of tectonosphere formation in the Antarctic region

The most intensive mantle flow of fluids, that has created the largest volume of a continental crust, took place in the Proterozoic time (Lutz, 1980). During this period the areas of the increased fluid flow was, obviously, the southern hemisphere as according to the paleomagnetic data all continents were located at this time in this hemisphere. That is in the Proterozoic in the a southern hemisphere a large heterogeneity in the form of lithosphere more than 300 km thick was formed, while in the northern hemisphere the thin crust of oceanic type was kept.

In Paleozoic there was a change in the position of paleomagnetic poles along which all continents moved from the southern hemisphere to the northern one (Storetvedt, 1997). According to thr rotation-fluid concept this moving was a result of a turn of the upper mantle or, what is more probable, of the whole mantle around the core. Only such movements were capable not to break the regularity in the surface and deep structure described above.

Moving of the large heterogeneity of the upper mantle as the thick continental lithosphere from the southern hemisphere to the north, caused a new displacement of the mass centers of the Earth spheres, the mass deficiency was formed in the southern hemisphere. It led to the following important stage of the global geodynamics: to the expansion of the southern hemisphere and formation of the mid-oceanic ridge system which is symmetric relatively to the South Pole and does not have corresponding subduction zones on the continents surrounding Antarctica (Fig. 2). This process is in accordance with the geological data which show that the mid-oceanic ridges started to develop from the south and expanded then to the northern hemisphere.

The expansion of the southern hemisphere is still proceeding. It is established, that now it is a little bit expanded relatively the northern hemisphere (Barkin, 2002). The restoration of the mass balance is also carried out by various reorganizations of the tectonosphere. Such well defined asymmetry of the sites of the Earth raised in one hemisphere and lowered in the opposite one is characteristic of all large tectonic structures. It is possible to assume, what it is such an alignment that promotes the formation of Antarctic continent and the corresponding destruction of the continental crust of the Arctic region. The high degassing also proceeds in the southern hemisphere (Sivorotkin, 2002).

4. Conclusion

Thus, three main stages may be defined in the development of the Antarctic tectonosphere structure. At the first stage, in the Proterozoic due to the intensive flow of deep fluids the continents with thick lithosphere were formed in the southern hemisphere. At the second stage, in the Paleozoic, most continents moved to the north and in the southern hemisphere there were only crustal fragments of the future Antarctica. In the Mesosoic time a new stage of development began - expansion of the southern hemisphere, formation of mid-oceanic ridges and the Antarctic continent.

An important advantage of such interpretation is the opportunity to explain many structural features of the Antarctic region and the history of its geological development on the basis of common sources. Each stage and reorganization follows directly from the previous stages: the formation of the continental heterogeneity in the southern hemisphere led the shift of this heterogeneity to the north, in turn this shift caused the expansion of the southern hemisphere, the formation of the global rift system and of the asymmetric Arctic and Antarctic regions.

Such interrelation explains the main structural feature of the Antarctic region: the presence of the ring of mid-oceanic ridges around the continent without the subduction zones corresponding to them. It contradicts to plate-tectonic conception of the global geodynamics. If the rift ring was formed only by spreading of the oceanic crust as it follows from the plate-tectonics, the Antarctica would be the area of all-round compression. But the subduction zones were not formed around it, and also the continent contains more zones of expansion, than those of collision.

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