

THE INFLUENCE OF NON-RADIOGENIC COSMIC HEAT GENERATION IN THE BOWELS OF THE EARTH AND PLANETS ON MUTUAL DISPLACEMENTS OF PLANETARY SHELLS**Article 2. Solar system planets polar and shells wandering****O.M. Makarenko**

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Multiple authors have previously expressed in the literature the hypotheses that a cosmic energy source could exist in the depths of Earth and other cosmic bodies based on theoretical considerations. Our comparisons of the properties of «space heaters» postulated by theoretical physicist with the properties of the non-radiogenic part of the heat release in the depths of the planets observed in geology and planetology show that a cosmic energy source could exist in the depths of Earth and other cosmic bodies with high probability. Besides radiogenic energy, the «supplementary» energy source occurs in the planetary interior. We considered the influence of supposed planet non-radiogenic energy source of cosmic (galactic) origin on the process of mutual displacements of planetary shells on the example of a number of planets. This source is of cosmic origin and modulated by position and direction of the Solar system motion in the Galaxy. Therefore, the maximal heat generation occurs when projection of the planet motion in the Galaxy achieves the planetary equator. This results in existence of hot equatorial belt in the planetary interior. Structure of convective flows with equatorial hot belt in the bowels of the planet including antipodally located superplumes is typical not only for the Earth, but also for the planets of the Earth's group and a number of satellites. This convection structure was formed in the initial era of existence of planetary system, possibly at the stage of accretion. It determines the specific character of redistribution of masses of substance in the bowels of the planet and the character of displacements of shells relative to each other. Movement of masses during convection leads to mutual nutation of shells relative to the planet's axis of rotation. These displacements occur in the allocated corridor between superplumes with respect to the axis connecting them. The displacements of shells set configuration for tension regions and network of planetary faults. The origin of this structure of convective flows is probably connected with the impacted process and cosmically conditioned heating of the near-equatorial belt of the planetary bowels. The results were obtained by comparing data from space geodesy, volcanology, paleomagnetism, paleoclimatic data for such planets as Mars, the Moon and Jupiter's satellite Europa.

Key words: mutual displacements (nutations) of planetary shells; true polar wander (TPW); superplumes; planets of the Earth's group; planetary satellites; non-radiogenic energy sources of the planetary bowels of cosmic origin.

ВПЛИВ НЕРАДІОГЕННОГО КОСМІЧНОГО ТЕПЛОВИДІЛЕННЯ В НАДРАХ ЗЕМЛІ І ПЛАНЕТ НА ВЗАЄМНІ ЗСУВИ ПЛАНЕТНИХ ОБОЛОНОК**Стаття 2. Рухи полюсів та оболонок на планетах Сонячної системи****O.M. Макаренко**

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Виходячи з теоретичних міркувань, деякими авторами в літературі була висловлена гіпотеза про можливість існування в надрах Землі та інших планет джерела енергії космічного походження. Наші співставлення властивостей запропонованого фізиками космічного джерела енергії з властивостями реально спостережуваної нерадіогенної частини внутрішньої енергії Землі та інших планет показали, що є ознаки дійсного існування такого джерела. Крім радіогенної енергії надра Землі та планет можуть мати «додаткове» джерело енергії космічного походження, котре модулюється положенням та напрямком руху Сонячної системи в Галактиці. Розглянуто вплив передбачуваного внутрішньопланетного нерадіогенного джерела енергії космічної (галактичної)

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природи на процес взаємних зсувів планетних оболонок. Залежність його від напрямку руху призводить до того, що максимальне вивільнення енергії відбувається, коли проекція вектора швидкості руху планети у Галактиці знаходиться на екваторі планети, наслідком чого є існування екваторіального гарячого поясу в її надрах. Структура конвективних потоків з екваторіальним гарячим поясом у надрах планети та антиподально розташованими суперплюмами, що входять до нього, характерна не лише для Землі, але і для планет земної групи та деяких супутників. Така структура конвекції сформувалася на початку існування планетної системи, можливо вже на стадії акреції. Вона визначає специфіку перерозподілу мас речовини у надрах планети та характер зміщень оболонок одної відносно іншої. Перерозподіл мас під час конвекції призводить до взаємних похитувань оболонок відносно осі обертання. Такі зміщення відбуваються у виділеному коридорі між суперплюмами відносно осі, що їх з'єднує. Зміщення оболонок задають конфігурацію областей напруження та сітки планетарних розломів. Походження даної структури конвективних потоків пов'язане, можливо, з імпактним процесом та космічно зумовленим нагріванням приекваторіального поясу планетних надр. Результати отримані шляхом співставлення даних космічної геодезії, вулканології, палеомагнетизму, палеокліматичних даних для таких планет, як Марс, Місяць та супутник Юпітера – Європа.

Ключові слова: взаємні зміщення (хитання) планетних оболонок; істинні рухи (дрейф) полюсів; суперплюми; планети земної групи; супутники планет; нерадіогенне джерело енергії планетних надр космічної природи.

ВЛИЯНИЕ НЕРАДИОГЕННОГО КОСМИЧЕСКОГО ТЕПЛОТЫДЕЛЕНИЯ В НЕДРАХ ЗЕМЛИ И ПЛАНЕТ НА ВЗАИМНЫЕ СМЕЩЕНИЯ ПЛАНЕТНЫХ ОБОЛОЧЕК

Статья 2. Движения полюсов и оболочек на планетах Солнечной системы

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На основании теоретических соображений многими авторами в литературе высказывалась гипотеза о возможности существования в недрах Земли и других планет источника энергии космического происхождения. Наши сопоставления свойств предполагаемого теоретически физиками космического источника энергии со свойствами реально наблюдаемой нерадиогенной части внутренней энергии Земли и других планет показали, что имеются признаки действительного существования такого источника. Кроме радиогенной энергии недра Земли и планет могут иметь «дополнительный» источник энергии космического происхождения, который модулируется положением и направлением движения Солнечной системы в Галактике. Рассмотрено влияние предполагаемого внутрипланетного нерадиогенного источника энергии космической (галактической) природы на процесс взаимных смещений планетных оболочек. Зависимость его от направления движения приводит к тому, что максимальное выделение энергии происходит, когда проекция вектора скорости движения планеты в Галактике находится на экваторе планеты, следствием чего является существование экваториального горячего пояса в недрах планеты. Структура конвективных потоков с экваториальным горячим поясом в недрах планеты и входящими в него антиподально расположенными суперплюмами характерна не только для Земли, но и для планет земной группы и ряда спутников. Данная структура конвекции сформировалась в начальную эпоху существования планетной системы, возможно уже на стадии аккреции. Она определяет специфику перераспределения масс вещества в недрах планеты и характер смещений оболочек друг относительно друга. Перемещения масс в ходе конвекции приводят к взаимному покачиванию оболочек относительно оси вращения. Эти смещения происходят в выделенном коридоре между суперплюмами относительно оси, их соединяющей. Смещения оболочек задают конфигурацию областей напряжения и сети планетарных разломов. Происхождение данной структуры конвективных потоков связано, возможно, с импактным процессом и космически обусловленным нагревом приэкваториального пояса планетных надр. Результаты получены посредством сопоставления данных космической геодезии, вулканологии, палеомагнетизма, палеоклиматических данных для таких планет, как Марс, Луна и спутник Юпитера – Европа

Ключевые слова: взаимные смещения (качания) планетных оболочек; истинные движения (дрейф) полюсов; суперплюмы; планеты земной группы; спутники планет; нерадиогенный источник энергии планетных надр космической природы.

1. Introduction

The influence of a supposed non-radiogenic energy source of cosmic (galactic) nature on the process of mutual displacements of planetary layers was reviewed in article 1 of the present work [Makarenko, 2019]. It is discovered that the configuration of convection in the Earth interior simultaneously has three options of the convective flows topology (single-cell, double-cell of open and closed types), the simultaneous existence of which is caused by uneven heating of the interior in space and time by an energy source of cosmic origin. Mass motions during convection leads to mutual fluctuation of the layers relative to the Earth's rotation axis. The fluctuations occur in a certain corridor, which is in the middle between the superplumes (African and Pacific) antipodally located at the equator. The axis, around which the layers are displaced, approximately coincides with the axis of the equatorial maximum moment of inertia and passes through the superplumes and positive geoidal undulations. Its existence is caused by global mantle isostasy.

In article 2 we will try to review as is the case with the "neighbours", what is known by these phenomena regarding the planets of the Earth's group and some large satellites. The structure and processes on these planets are in large measure similar to the Earth ones, but their sizes vary significantly, they are at different stages of their evolution, which allows us to count on some new information on the processes being studied. This is the task of the article.

2. Fluctuations of layers and true polar wander on the planets of the Solar system

If in the case of the Earth the polar wander is "noised" by the mutual displacements of the lithospheric plates, then a planet such as Mars, where plate tectonics, apparently, has not been developed, gives us the opportunity to have a look at the process "in its pure form".

Fig. 1 shows the areoid of Mars. As in the case of the Earth's geoid [Makarenko, 2019], we see two global areas of exceedances over the rotation ellipsoid. Both of them are associated with the equator. The areas of the Martian volcanism development are shown in the figure. The same correlation with the bulges of the Mars figure is visible, as is observed for the Earth.

The dominant point of view is that we are up against two ascending global flows of the mantle

(superplumes). This is also confirmed by the presence of the giant rift system on one of the bulges of the areoid - the Valles Marineris, which is an indicator of the extension environment that prevailed both in the elevation area and in the equatorial zone in general.

As in the case of the Earth, *convection on Mars is also double-cell and both ascending flows are located at the equator*. One flow is more concentrated, the other looks weaker, but occupies a larger territory. Volcanism precisely in these areas occurred to one degree or another throughout the entire or most part of the Mars history. For example, for the Tharsis volcanic province occurrences of activity are known in the range from 3.5 billion years to tens of millions years ago (which cannot be said about adjacent areas). It can be stated with a certain degree of confidence that *the geographical location of the ascendant flows remained virtually unchanged the whole time*.

But what is known about the drift of the Martian poles? The geological analysis of the circumpolar territories carried out in [Kite et al., 2009] showed that, despite the fact that modern polar caps are located symmetrically relative to the rotation axis, deviating at average by no more than 2.4° , the centroids of ancient circumpolar deposits are shifted by $5-10^\circ$ (Fig. 2). It has been suggested that this phenomenon is caused by displacements of the Martian lithosphere relative to the rotation axis of the planet in course of the redistribution of masses during the formation of number of the largest volcanic provinces. It turned out that *the ancient poles of the rotation axis of Mars are located in a certain corridor along the meridians located at an angle of 90° relative to Tharsis - the largest of the volcanic provinces located at the equator and spatially associated with one of the Mars superplumes* (Fig. 1). The design data confirms these observations. *The displacement corridor of the Martian poles is located in the area of descending convective flows between two giant equatorial superplumes*.

Same deposits similar to polar ones were found in the subequatorial latitudes [Schultz, Lutz, 1988] (Fig. 1). They are also located within the displacement corridors defined above. It is seen that the amplitude of the displacements is quite large - sometimes the poles reach the latitude of the former equator.

The permafrost distribution on Mars also provides important information on the movements of

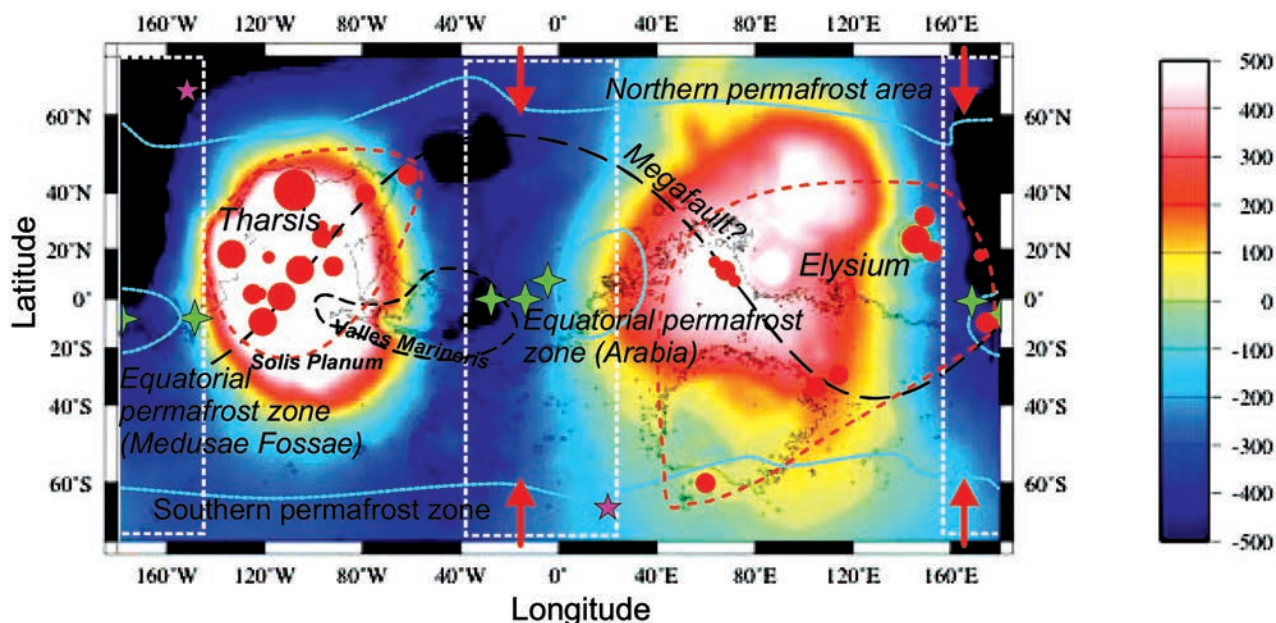


Fig. 1. Martian Areoid, model JOD75E60 [Phillips et al., 2001], polar shift and volcanic activity of the Mars. We can see two areas of elevations of areoid over the ellipsoid of rotation. The centers of these areas are located on the opposite sides of the equator. Also, it is shown areas of volcanism development (red dots are the largest volcanoes on the Mars). The arrows indicate the expected direction of the pole drift according to [Kite et al., 2009]. As in the case of the Earth, they move along meridians, which are equidistantly located from the equatorial superplumes. This is confirmed by the reconstruction of the paleopoles by presence of near-polar deposits (green asterisks [Schultz, Lutz, 1988]), as well as location of paleomagnetic poles is marked with violet color [Sprenke, 2007]. Blue dashed lines outline the permafrost areas observed both in the vicinity of the modern poles and in two foci on the antipodal sides of the equator, which also serves as an indication of location of poles in the past. The probable location of the largest Martian fault is also shown

Рис. 1. Марсианский ареоид, модель JOD75E60 [Phillips et al., 2001], смещения полюсов и вулканическая активность Марса. Видны две области превышений ареоида над эллипсоидом вращения. Центры этих областей расположены на противоположных сторонах экватора. Также показаны области развития вулканизма (красные точки – крупнейшие вулканы Марса). Стрелками показаны предполагаемые направления дрейфа полюсов по [Kite et al., 2009]. Как и в случае Земли, они смещаются вдоль меридианов, равноудаленных от экваториальных суперплюмов. Это же подтверждает реконструкция палеоплюсов по наличию околополярных отложений (зеленые звездочки [Schultz, Lutz, 1988]), а также расположение палеомагнитных полюсов (фиолетовое) [Sprenke, 2007]. Голубыми пунктирными линиями оконтурены области мерзлоты, наблюдающиеся как в окрестностях современных полюсов, так и двумя очагами на антиподальных сторонах экватора, что также указывает на расположение здесь полюсов в прошлом. Показано также вероятное расположение крупнейшего марсианского разлома

its rotation axis. For the purpose of water search on Mars using a special equipment located on the “Mars Odyssey” spacecraft, neutron emission maps of this planet were created. Spatial variations of the neutron current show the hydrogen content in the subsurface layers of the soil, since hydrogen is an effective neutron moderator. The only chemical substance that can explain a high hydrogen content in Martian soil is water. It has been discovered that in the polar regions of Mars, from about 60-67° from latitude, there are vast areas of permafrost with a very high (from 20 to 50 mass percent) content of water ice in the subsurface layer of 1-2 m thick. In the subequatorial regions the water content is much lower. The driest soil was in the area of the Solis Planum (Fig. 1) – about 2%. However, at equatorial

latitudes in the area of 50-350° e. l. and 180-210° e. l. two areas were found (Fig. 1) where the mass content of water reaches 10%. The mutual antipodality of these areas and the special nature of the deposits composing them led researchers to the conclusion that once there were the geographical poles of the planet (more precisely, this territory was located in the area of geographical poles).

Since there is every reason to consider that, as in the case of the Earth, the magnetic poles of Mars, in general, coincided with the poles of the rotation axis at quite long time intervals, the history of the Mars magnetic field can provide information on the drift of the geographical poles of this planet. Present-day Mars is practically devoid of a magnetic field, but traces of its former presence 3.5–4.4 bil-

Fig. 2. The Southern polar region of the Mars, theoretical and observational coordinates of the location of the paleopoles [Kite et al., 2009]. The paleopolar deposits of three different ages are shown by filling. Green circles are centroids of these regions indicating the supposed location of poles of the Mars in the corresponding epochs. Triangles are the calculated values of the response of axis of rotation of the Mars to formation of the largest volcanic provinces. The arrows show direction to the ascending convective mantle flows (superplumes) located on the equator, which are determined by location of areoid elevations over ellipsoid of rotation and volcanic activity. The redistribution of masses on the Martian surface (and in its bowels) leads to change in position of the axis of rotation of the Mars. Displacement occurs along a large circle, located equidistantly from the superplumes

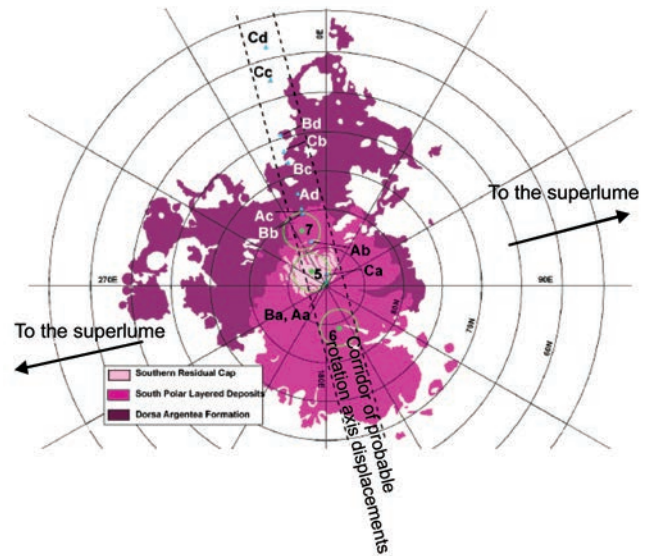
Рис. 2. Южная полярная область Марса, теоретические и наблюдательные координаты расположения палеоплюсов [Kite et al., 2009]. Заливкой показаны палеоплюсовые отложения трех различных возрастов. Зеленые круги – центры этих областей, указывающие на предполагаемое расположение полюсов Марса в соответствующие эпохи. Треугольники – расчетные значения отклика оси вращения Марса на образование крупнейших вулканических провинций. Стрелками показано направление на расположенные на экваторе восходящие конвективные потоки мантии

lion years ago (Fig. 1) remained in the form of magnetization of rock formation area of the corresponding age. Magnetic anomalies make it possible to determine the position of the ancient magnetic poles of Mars at a certain point of its history. Fig. 1 shows one of these reconstructions [Sprenke, 2007]. It is apparent that the location of the ancient magnetic poles of Mars generally lies close to the corridor in which the rotation axis moved according to climatic data and theoretical calculations.

Since Mars is a relatively rapidly rotating planet, the movement of the rotation axis along its surface will be followed by a change in its figure, and, accordingly, tensions and the consequential fault tectonics will occur in its lithosphere. It can be noted (Fig. 1) that many volcanoes of Mars are located in a non-random manner, grouping around a certain circle surrounding the entire planet and passing through the centres of the areoid of Mars. It can be assumed that this line is a megafault formed specifically by the displacements of the Mars rotation axis. The case of Mars is not unique.

Let's consider data on other planets.

Fig. 3 shows a lunar geoid (selenoid). The exceeds above the rotation ellipsoid are extended in a wide strip along the equator. On this strip two gigantic elevations located opposite each other are clearly visible. One of them is located in the centre



(суперплюмы), определяемые положением превышений ареоида над эллипсоидом вращения и вулканической активностью. Перераспределение масс на марсианской поверхности (и в его недрах) приводит к изменению положения оси вращения Марса. Смещение происходит вдоль большого круга, расположенного на равном удалении от суперплюмов

of the lunar nearside, the other, accordingly, on the farside, on the axis connecting the Moon with our planet.

This configuration perfectly correlates with the anomalies of the gravitational field of the Moon. Significant inhomogeneities of its gravitational field were discovered even during the very first flights of spacecrafts near the surface of the Moon, which seriously affected the flight paths of these vehicles (through to their fall on the lunar surface). The anomalies are caused by special massive formations in the interior of the planet (from 10^{-6} to 10^{-4} mass of the Moon), which are called «mascons» (from «mass concentration»). Their origin is associated with the impacts of large cosmic bodies, which formed giant depressions in the terrain. The formation of these depressions was subsequently partially compensated by an isostatic uplift of the underlying more dense mantle masses. In this manner, the lenses of more dense matter under impact basins led to gravitational anomalies.

However, this buckling of the underlying masses did not occur under all depressions, but only in certain areas, which, as can be seen in Fig. 3, coincide with two gigantic excesses of the Moon figure over the rotation ellipsoid. The mascons are located under large circular seas – Mare Imbrium, Mare Nubium, Mare Serenitatis, Mare Crisium, Mare Nec-

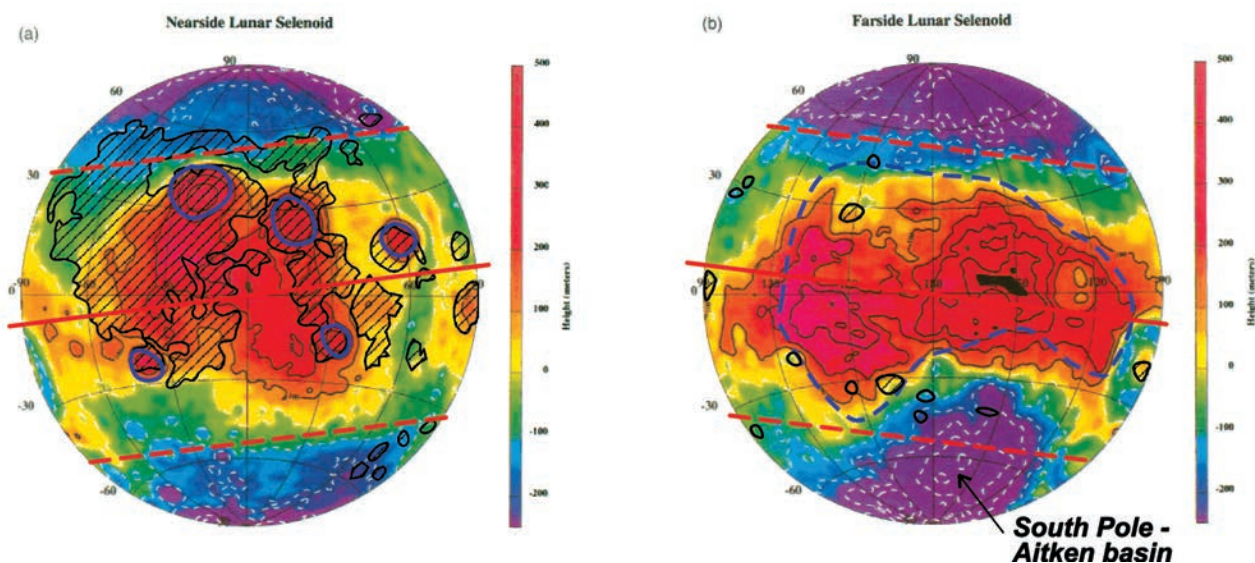


Fig. 3. Lunar geoid or selenoid: a) lunar nearside; b) lunar farside [Konopliv, Yuan, 1999]. Here we can see a belt stretching along the equator elevated above the ellipsoid of rotation with two heights, which are laid opposite each other. By analogy with other planets, these heights and the belt itself can be interpreted as manifestations of ascending convective flows in the lunar mantle; here is also double-cell convection. In addition, location of lunar mascons are shown with blue contours [Konopliv et al., 2001], that is positive gravitational anomalies under the surface of the Moon, which are the result of rise of dense mantle masses. The shaded areas are lava seas of the Moon. Internal activity in the polar latitudes was practically absent. All manifestations of internal activity are located along the hot belt, which is inclined 5-7° to the current equator and is, apparently, the imprint of the ancient equator of the Moon. The displacements of axis of rotation occur in complete analogy with the Earth and the Mars – relative to the axis connecting the equatorial superplumes

Рис. 3. Лунный геоид или селеноид: а) ближняя сторона; б) дальняя сторона [Konopliv, Yuan, 1999]. Виден протянувшийся вдоль экватора пояс превышений над эллипсоидом вращения с двумя расположившимися напротив друг друга возвышениями. По аналогии с другими планетами эти возвышения и сам пояс можно интерпретировать как проявления восходящих конвективных потоков в лунной мантии; конвекция здесь тоже двухъячеистая. Также синими контурами показано расположение лунных масконов [Konopliv et al., 2001] – положительных гравитационных аномалий под поверхностью Луны, являющихся продуктом подъема плотных мантийных масс. Заштрихованные области – лавовые моря Луны. В полярных широтах внутренняя активность практически отсутствовала. Все проявления внутренней активности расположены вдоль горячего пояса, который наклонен по отношению к современному экватору на 5-7° и является, по-видимому, отпечатком древнего экватора Луны. Смещения оси вращения происходят в полной аналогии с Землей и Марсом – относительно оси, соединяющей экваториальные суперплюмы

taris, Mare Humorum, Mare Orientale. Also, mascons were found in the central part of the Moon farside (occupying an area with a diameter of about 1 thousand km) and in the region of the Mare Marginis. Only here the mantle substance turned out to be quite movable. Moreover, which is typical, there are several mascons on the lunar nearside, they are large and clearly defined, while on the farside the mascons are small, but there are many of them and they occupy a rather vast area.

In general, two types of surface topography are distinguished on the Moon: continents – elevated uneven densely cratered light areas; and the seas – younger and relatively even dark areas of the surface filled with hardened lava, lying significantly lower the level of the crust mainland (by 1-3 km).

Sea areas are distributed very unevenly on the surface, forming an irregularly shaped belt. The seas located on the Moon farside, are much smaller than those on visible from the Earth; in addition, there are very few of them. In the visible hemisphere of the Moon they occupy about 31-40%, and on the opposite – 3-10% of the entire territory. The belt of the seas on the reverse side continues with the so-called thalassoids (sea-like structures) – bright low-lying areas that were not flooded with lava. Several small seas found on the opposite side are located in the centres of the thalassoids.

The lunar seas fill the largest impact basins that formed during the era of the giant meteorite bombardment or lunar cataclysm that occurred about 4 billion years ago, and by their structure and inten-

sive basaltic magmatism most resemble the Earth's trappean provinces. The seas were filled with basaltic lava 3.9-3.0 billion years ago and it is not directly related to impact events itself, because these processes are separated by a time interval of hundreds of millions years. It is generally accepted that impact depressions turned out to be simply the most convenient (attenuated crust, fractured by a network of faults) place for some of the mantle matter to break through to the surface in the form of lava and fill part of this depression. Again, as in the case of mascons, not all large impact depressions are filled with lava seas. So, in the largest impact basin known in the Solar system – the South Pole - Aitken basin – neither the lava seas nor the mascons formed. As seen in Fig. 3, *lunar lava seas are concentrated all in the same areas of selenoid excedances.*

From all mentioned above, it can be concluded that these areas located at the equator are areas of ascending convective flows of the mantle. Nowadays, we can talk about convection only in the deep layers of the mantle, not exceeding half of the Moon radius; therefore, the observed represents rather traces of the topology of convection that was inherited to the Moon at the dawn of its history.

Also interesting is the fact that, as it can be seen in Fig. 3, the lunar hot belt is also sloped to the present-day equator at a small angle of about $5-7^\circ$ and, apparently, is a print of the ancient equator of the Moon. This, apparently, cause the fact that the axis of the maximum moment of inertia of the Moon lies in the same range of $5-10^\circ$ from the current rotation axis, while the axis of the minimum moment of inertia lies in the direction toward the Earth. The displacements of the rotation axis occur in perfect analogy with the Earth and Mars – relative to the axis connecting the equatorial superplumes.

Magnetic anomalies caused by residual magnetization of ancient lunar rocks were discovered during the early explorations of the Moon by means of spacecraft. These anomalies make possible to reconstruct the location of the paleomagnetic poles of the planet. Based on the directions of magnetization of 35 such anomalies, the locations of their corresponding poles were determined in [Hood, Russell, Coleman, 1978]. It has been discovered that they are grouping in antipodal areas lying near the east-west equatorial axis of the Moon, i.e., they are located near the present-day equator at approximately equal distance from the lunar superplumes.

In other words, as in the case of Mars and the Earth, the amplitude of the displacements is quite large – the poles sometimes reach the latitude of the former equator. It is known that the cratering of the lunar surface depends on which side the moon moves in space, rotating around the Earth. In the direction of movement, impact events should occur 29% more often than from the opposite side (for the present-day population of asteroids approaching the orbits of the Earth and the Moon). Consequently, knowing the distribution of craters on the lunar surface and their relative age, we can suggest which side of the Moon was directed along the path of movement in a particular era.

This work was performed in [Wieczorek, Le Feuvre, 2009]. It turned out that generally the most ancient craters are concentrated on the side opposite to the direction of movement, and only the younger ones have the “correct” location in the direction of movement, that is, reorientation (“somersault”) could most likely occur. In [Wieczorek, Le Feuvre, 2009] it is suggested that this reorientation of the hemispheres was caused by the impactor, which formed one of the large lunar seas, but it also could be connected with the convective redistribution of masses in the lunar mantle. There is also a slight north-south asymmetry – there are more craters on the southern side of the Moon, i.e., it may be that the current southern side of the Moon was more often directed along the path of movement. We note that such “somersaults” were supposed by different authors in relation to the Earth.

There are no clear traces of the displacements of their layers relative to their rotation axis on Mercury and Venus. Nevertheless, there is some evidence that confirms the existence of equatorial belts of internal activity on these planets; moreover, two ascending antipodally located convective flows in the structure of the belts are also seen. Consequently the outer layers on these planets also experienced displacements around the axes connecting convective flows.

The excess masses present in the areas of development of equatorial ascending convective flows (superplumes), apparently, determine the specific feature of the Mercury rotation – being close to the Sun and experiencing tidal deceleration from its direction, Mercury rotates with a period comparable (but not equal) to the rotation period around the Sun, at the same time, every two Mercury years, the side

where one of the superplumes is developed appears at a subsolar point when the planet is in perihelion point.

On the Moon, as it has been seen, gravitational anomalies and convective flows are located on the both sides of the planet on the axis that spatially connects it to the Earth. Moreover, specifically the most abnormal side of the Moon is turned towards the Earth.

The rotation of Venus, the planet closest to us, also has an interesting feature. Its speed is such that during its approach to our planet, the same side of Venus is turned towards the Earth all the time. One of its ascending mantle flows is located precisely on this side.

Apparently, we are dealing with a curious variety of resonant gravitational phenomena in the movements of celestial bodies caused by the features of the distribution of masses in their interiors, that, in its turn, is determined by the convection

plan in the mantles of the planets, which is predetermined by cosmic causes lying outside the Solar system.

Another interesting planet in terms of layer displacements is Europa. Among the mysterious features of this satellite of Jupiter are arc-shaped narrow guttered cavities – throughs, which form with their arcs two huge incomplete circles with a diameter of about 2,500 km on opposite sides of the planet with centres lying on its equator (Fig. 4). It has been suggested that their formation is related to the polar drift, or, more precisely, to the displacement of the many kilometres long ice shell of the planet regarding its liquid water mantle. It is assumed that the ice accumulation at the poles leads to tipping over of the formed excess mass to the equator (on average by 80°), and its subsequent melting there (obviously, in the hot belt) returns the system to its initial position [Schrenk, Matsuyama, Nimmo, 2008]. The planet is also covered with a

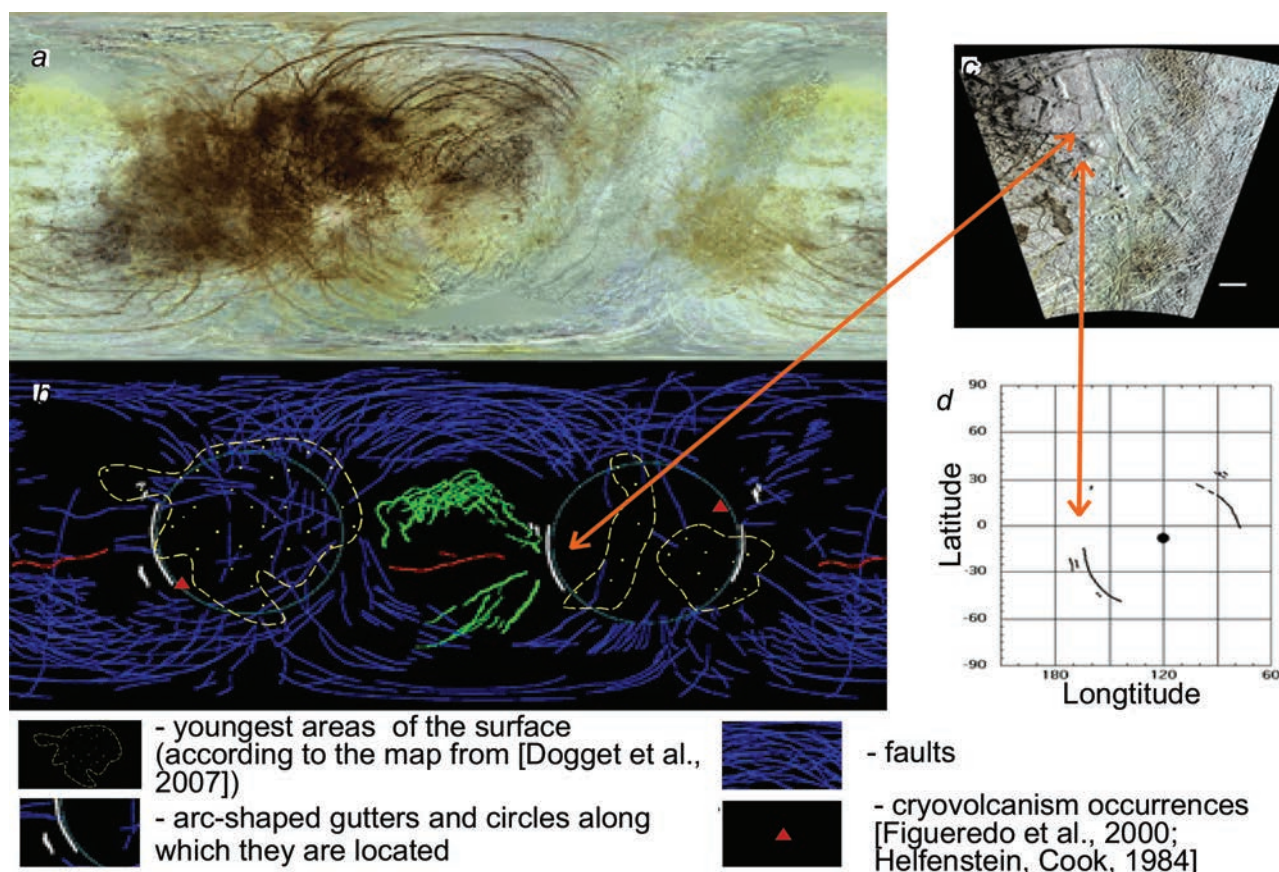


Fig. 4. The surface of Europa as an indicator of structure of convective flows of its bowels: a) the global mosaic of photographs; b) map of faults; c) photographic image of an arched trench; d) its location relative to the equator. Figures are taken from [Schrenk et al., 2008]

Рис. 4. Поверхность Европы как индикатор структуры конвективных потоков ее недр: а) глобальная мозаика фотографий; б) карта разломов; в) фотографическое изображение дугообразного желоба; г) его расположение относительно экватора. Рисунки взяты из [Schrenk et al., 2008]

network of global cracks or “furrows” caused by a change in the shape of its outer ice shell during its fluctuations relative to the rotation axis. These furrows form a symmetrical pattern, located in bundles along two circles that intercross at the centres of the arc-shaped gutters (Fig. 4).

Europe is a mildly cratered planet with a frequently renewed young (about several tens of millions years) surface. From photographs taken by the “Voyager” and “Galileo” spacecrafts, a geological map of Europa with distinction of four main age groups was created [Doggett et al., 2007]. According to this map fig. 4, *b* shows the locations of territories with the youngest surface. Also assumed occurrences of cryovolcanism according to [Figueredo et al., 2000] are additionally shown. The association of these young recently renewed areas with the centres of the arc-shaped gutters is obvious, and numerous furrows, that abundantly occur on the planet’s surface, merge here, that can be interpreted as the presence of ascending convective flows of the Europe’s water mantle in these places. Two other intermediate age groups are generally concentrated in the vicinity of the equator. The picture is very similar to what we saw on other planets – two giant superplumes at the equator form bulges, relative to which fluctuations of the outer layer associated with the redistribution of masses in it occur. Here superplumes are also components of the planet’s hot equatorial belt.

Suggestions regarding similar displacements of the outer layers were also made regarding Ganymede, Miranda and a number of other large ice planets.

3. Discussion and conclusions

To summarize, we can conclude the following.

Throughout the entire period of their existence in the interiors of the Solar system planets there has been a single topology of convection, the main feature of which is the equatorial hot belts with two antipodally located and isostatically lifted above the substrate superplumes.

The displacements of the Earth and planets layers caused by the motion of the matter masses during the interplanetary convection occur in certain corridors located perpendicular to the axis firmly held at the equator connecting the ascending convective flows. Accordingly, the central points of the equatorial superplumes are the poles of the axis around which the fluctuation of the layers occur.

On such a large planet as the Earth, with ongoing internal activity, the equatorial superplumes look quite equivalent. On smaller planets, where internal activity became extinct at the early stages of evolution, one of the superplumes looks more well-defined, while the antipodal one is less clear and seems to be blurred in space.

From this, the following considerations arise regarding the formation of antipodal equatorial superplumes and layer fluctuation corridors. Initially, cosmic energy in the interiors of the planets is released mainly in the subequatorial zone (for the reasons stated in [Макаренко, 2011, 2012]). Even in the era of planet accretion, sooner or later, a large cosmic body falls out of the protoplanetary cloud to the planet surface in the subequatorial zone and an impact basin is formed. Under it, by the action of hydrostatic alignment forces, a mascon is formed – a positive gravitational anomaly (the example of the Moon shows that the formation of mascons is possible precisely in the equatorial relaxed zone). This mascon serves as some a kind of an “anchor”, holding the layer exactly at this place at the equator (these are the laws of mechanics).

Meanwhile, convection develops in the interior of the planet, mass redistributions occur, and the planet continues to grow as a result of its bombardment by bodies from a protoplanetary cloud, i.e. the planet is tilting all this time, “is in a whirl”. However, the fluctuation of the “anchored” zone is difficult; it is more often located in the equator area, where heating occurs. So the first (master) ascending convective flow (superplume) is formed. As the planet rotates, the antipodal side also becomes more stable, although it is subjected to more significant “tilting” (there is no “anchor” there). Since the antipodal zone is also attached to the equator to some extent, it is predominantly heated too. So the second antipodal (slave) ascending convective flow (superplume) is formed. The position of this flow is less stable, it is not so rigidly attached to the equator and occupies a wider zone, spatially “blurred”. Therefore, the surface occurrences of the planet’s internal activity are less represented.

Such separation, apparently, is characteristic only of the initial stages of history of the planets and remained only on small-sized planets. The specified inequality is imprinted, apparently, in the structure of such planets as the Moon and Mars that relatively quickly lost internal activity. The

general topology of convection remains unchanged throughout the entire history of the existence of a convecting planet (what we know from the history of Mars).

Accordingly, the poles of the layer fluctuations spatially coincide with the axes of two antipodal superplumes at the equator and maintain their place throughout the history of the planet.

The layer wanderings themselves occur meridionally along the corridor between superplumes. Externally, it looks like a centuries-old polar drift (both geographic and magnetic). The amplitudes of such displacements are quite large (former poles may approach the equator).

Such fluctuations are characteristic not only of the outer rock shell, but also of the inner core of the planet. The layer motions are probably gravitationally synchronized; there are certain resonances in these motions. Similar phenomena are observed

in interactions between cosmic bodies (planets). In some cases, they are preferably turned to each other with their superplumes (i.e., they are in certain resonances).

Such is the influence of the “space heater” on the relative displacements of planetary layers. Previously, these displacements were not analysed in such a complete amount of data and in comparison with similar phenomena on other planets. The reasons for precisely such features of the layer motions (in a special corridor, etc.) were not clear.

A heat source that naturally changes in space and time should most certainly affect other geological processes, such as the movements of lithospheric plates, the generation of a geomagnetic field, etc., however, these issues require further investigation (a preliminary study shows that such influences do exist).

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