THE ANISOTROPY OF THE EARTH'S INNER CORE AND THE GEOMAGNETIC FIELD

V.V.Kuznetsov
Institute of Geophysics, Siberian Branch of Russian Academy of Sciences. Koptyug Avenue 3, 630090 Novosibirsk, Russian Federation (E-mail: kuz@uiggm.nsc.ru)

Abstract

A model relating the cylindrical and the lateral anisotropy of the inner core to the circuit of the generation of the geomagnetic field is offered. The phenomenon of the anisotropy of the properties of the inner core consists in the fact that the time a seismic wave takes to traverse the core along the rotation axis is 0.5 % less than the time taken in the equator plane. Another piece of evidence comes from the splitting of the Earth's proper oscillation spectra. In addition to the velocity difference between traversing the core along and normal to the rotation axis, a inner core lateral anisotropy has been discovered both from function splitting and travel time data. The lateral anisotropy shows that the velocities of P-waves over the surface of the inner core at the regions, projected into the Earth surface at the Pacific and at the Atlantic oceans, are 0.2-0.4 % less than these at the poles and at the continents.

The model of geomagnetic field generation is based of current differential loop looking like the double cylinder and taking place on the inner core boundary, at the F-layer, in the plane of equator. A model in which the cylindrical anisotropy of the core results from dissipative processes, accompanying the geomagnetic field generation is offered. The attempt to explain the interrelation of the lateral anisotropy of the core and the morphology of the geomagnetic field is made.

Keywords: Earth inner core anisotropy; geomagnetic field

1. Introduction

The phenomenon cylindrical and lateral anisotropy, recently was revealed and is widely discussed now. The phenomenon is, that the velocity of seismic P-waves touching boundary of an inner core and spreading parallel spin axis of the Earth, appears approximately on 0,5 % above, than velocity of waves spreading across a spin axis. This view of an anisotropy has received the name cylindrical. The analysis of a plenty seismograms from strong earthquakes is carried out which has allowed to reveal, as far as the P-wave coming to the receiver from earthquake under a corner approximately 140-150 degrees, and touching inner core boundary (ICB) focused along a spin axis of the Earth, comes earlier, than same wave spreading in the field of an inner core across a spin axis. As a result of processing many thousand seismograms, was found out, that in the first case the P-wave comes on some seconds earlier, than in second. This method is termed travel-time. The results proved to be true by other method, in which the analysis of Earth's free oscillations (EFO), incipient after strong earthquakes was yielded. It was revealed, that the EFO spectrum is combined enough and contains a plenty of multiplets. The multiplets arise (that naturally) for the account nonspherical of the Earth, bound with its by rotation. However was found out, that in a EFO spectrum there are absolutely other multiplets, which carry the information on features of a structure of Earth's interior envelops down to an inner core. This method of the analysis of split of EFO spectrums has called of splitting-functions.

The explanation of the phenomenon observed is based on the concept of chemical and mineralogical composition of inner core. According to the conventional view the core consists of the hexagonal close-packed iron. In the pT-conditions of the inner core this iron can supposedly manifest properties of cylindrical anisotropy similar to those that seismic observations reveal. It is absolutely clear that iron can exhibit these properties if it is in a single-crystal or similar state. Some others think that there is a convection in the inner core and it is responsible for anisotropic properties of substance of the core. In this case the substance of the core should move in the center along the rotational axis so that it "flows out" of one pole and then "flows in" at the other pole. These authors believe that the substance (i.e. single-crystal iron) is in a partially molten state (!?) in the core. Another author supposes (Karato, 1993) that iron can acquire the properties of cylindrical anisotropy if it experiences the action of the magnetic field of Earth. Clearly, Karato assumed that iron in the inner core had a magnetic (paramagnetic) susceptibility for the action to be possible. Finally, the third explanation was proposed. Its idea is that iron minerals has a preferred orientation because of rotation and self-gravitation in the process of crystallization and growth of the inner core. Tromp (1995) thinks that "it does not seem impossible that the inner core is a single huge crystal".

2. Data of the anisotropy

Travel-time. In studying the anisotropy of velocities of P-waves in the inner core the authors of one of the first papers from this cycle (Poupinet et al., 1983) calculated the difference in travel time for PKIKP-waves and P-waves. Analysis of 400 records of 143°-traces of PKIKP-waves has shown that the difference in travel time between polar and equatorial paths is about 2 - 4 s. The authors distinguish two "slow" regions in Pacific and Atlantic oceans. "Fast regions" are located in continental parts of North America, Asia, and also Australia and New Zealand. The difference between slow and fast regions is about 2 s. The study of traces of PKIKP-waves propagating at other angles has shown that the major inhomogeneity responsible of the time delay is not distributed uniformly on a radius in the inner core and that it is concentrated near the boundary. This result has been refined in a later paper (Song, Helmberger, 1993). Here seismic traces of nuclear explosions were also used. The authors arrived to the definite conclusion that the anisotropic wave properties of the inner core manifest themselves primarily near its boundary with the outer core.

Creager (1992) comes to the conclusion that there is a layer about 70 km in thickness, that it is located at a depth of 100-300 km beneath the surface of the inner core, and that it is "responsible" for its anisotropical wave properties. In his opinion the cylindrical anisotropy is not the best approximation for theoretical model and for results of observations. For a better coincidence Creager shifts the axis of anisotropy by 5° relative to the rotational axis of Earth and places it into the point with coordinates 85° S and 300° E

Analyzing times of arrivals PKiKP of waves from nuclear explosive on epicentre distances (Adushkin et al., 1997) about 6° (≈ 690 km), have found out in the outer core basis of a layer by thickness of 3 km with the abnormal performances: in density 12,1 g/cm^3, velocity of P-waves 12,0 km/s and spring of density 0,6 g/cm^3.

Splitting-functions. In a number of papers (Tromp, 1995; Woodhouse, Giardini, 1985; Woodhouse et al., 1986) and, especially, in (Giardini et al., 1988), which we will primarily follow, Tromp, Woodhouse, and Giardini developed a technique of synthesis of oscillation spectra and evaluation of coefficients c_{st}. These coefficients fully describe the splitting of a give multiplet $s = 0, 2, 4$. These coefficients are presented by a special splitting function $h\ (q,\ j)$. Below we shall clear out the physical meaning of this function and the associated coefficients c_{st}.

The study of anisotropy of splitting of multiplets for free oscillations of Earth is finally reduced to determination of $dm_{st}(r)$ through calculation of spectra with the use of seismograms. Given $dm_{st}(r)$ and the source and receiver parameters the coefficients c_{st}

can be determined. For example, let us assume that inhomogeneity gives birth to maximal number of multiplets $s_{max} \leq 2\,l$. Then the number of coefficients is:
$s_{max} = 1/2(s_{max}+1)(s_{max}+2)$.
For example, for the mode of degree 2, for which $s_{max} = 4$, there are only 15 coefficients c_{st} and they represent all the spectra of this mode.
The representation of the splitting coefficients c_{st} is given by the splitting function:

$$h\,(q, j) = \sum_{s=0}^{2l} \sum_{t=-s}^{s} c_{st}\, Y_s^t\,(q, j).$$

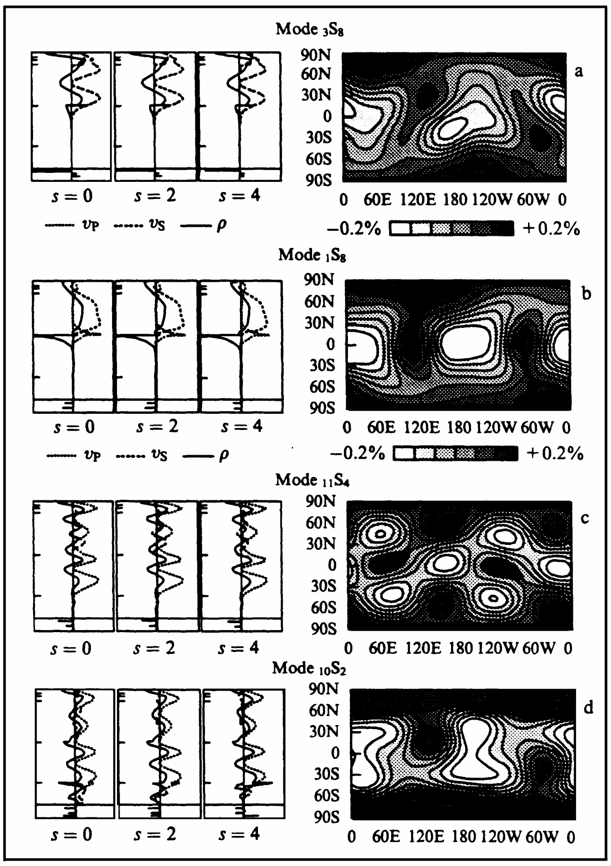

Fig. 1. Splitting functions for different modes of free oscillations of Earth are shown on the right. Intensity changes from -0.2% (white) to +0.2% (black). Distributions of intensity of free oscillation in depth (in Earth's radius) for three different S (0, 2, 4) (kernels) are shown on the left. Kernels function is presented as changes in velocities of P-waves and S-waves and in density (r) with depth. a) and b) Splitting and kernels functions of mantle; c) splitting and kernels functions of outer core; d) splitting and kernels functions of inner core.

The distribution of splitting function in depth (kernels) and over the Earth surface reflects the three-dimensional structure of Earth very closely. Today distribution patterns are built for many sets of multiplets, each of which has its own intensity distribution in depth (its own kernel). Figures 1-a, 1-b, 1-c, and 1-d show several patterns, each of which presents variations of splitting function at depths of mantle, inner and outer cores. The function itself is normalized by the 1% perturbations of P-wave speed, S-wave speed, and density (r).To the left from the patterns there are distributions of perturbations dr/dr, dv_p/dr and dv_s/dr in depth (kernels). The following lines are marked: the free (day) boundary, the discontinuity in mantle at a depth of 670 km, the core-mantle interface and the boundary of the inner core.

3. Identity of the Earth envelopes

The inner core and mantle splitting functions are symmetrical about equator and are alike: each of them has two maximums and two minimums outstanding each other about 90°. The splitting function pattern is fully identical to lateral anisotropy pattern, produced by travel time data. Let's show two sections (through equator and zero meridian) of inner core and mantle (as its boundary with the core) splitting functions patterns. The pictures show the similarity of Earth spatial structure nearly ICB and OCB (see Fig. 2).

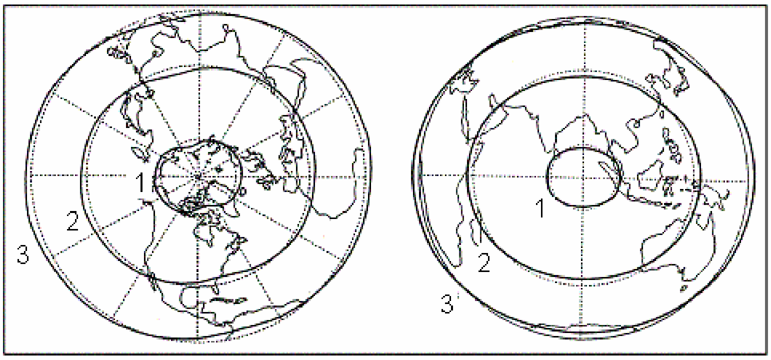

Fig. 2. The lateral anisotropy of the inner core - 1, the mantle - 2. Height of the geoid -3. Left, section of the equator; right, section of the zero meridian.

The same sections of geoid heights are given. We see the full similarity of inner core anisotropy distribution in mantle and in geoid height. Note that the outer core splitting functions pattern differs from the patterns of the inner core, mantle and geoid. The P-wave velocity is higher at the regions of the inner core, projected into the continents, than at the regions, projected onto the Pacific and the Atlantic oceans. The picture shows that nearly the ICB the increase of P-wave velocities correlates with the decrease of core radius, or v_p is increasing by the Earth center, $v_p \sim 1/R$. Let's use the well, known values of velocity gradient dv_p/dR at the splitting functions variation regions. Then with the velocity gradient dv_p/dR = 1 km/s/100 km and with the velocity $v_p \approx 10$ km/c the change of splitting function value of 1 % is equivalent to DR = 10 km. Our estimations of the inner core cylindrical anisotropy are of the same order 20 km. The variations of the splitting functions at the core mantle boundary have much the same $DR \approx$ (20 – 40 km). Note, that maximum spread in the heights of geoid values us much less (± 60 m).

Now we shall turn out attention to attempts to find a plausible explanation of the phenomenon of anisotropy of the inner core. The dominant part of authors (Tromp, 93; Tromp, 95; Masters and Gilbert, 1981) and others believe that this phenomenon is related to the peculiar structure of the inner core, in which the single crystal of iron is oriented along the rotational axis of Earth. Morelli et al. (1986) think that this anisotropy "is not physically impossible" though it is unclear how it can appear. Other authors try to explain the existence of such anisotropic single crystal made, as is believed, of iron in a hexagonal close-packed phase by convection in the inner core (convection in a single crystal?) (Jeanloz and Wenk, 1988), or by influence of magnetic field on its growth (Karato, 1993). The so called true polar wander is invoked quite out of place for the purpose of explanation (Jeanloz and Wenk, 1988) because it is supposedly affect the flow of iron along the axis, etc. (!?). These attempts seem quite unconvincing so there is no sense to dwell on them any more. The more so as no one of these five results is discussed specially in any other work (Morelli and Dziewonski, 1987; Creager, 1992). Note that our review covers more than 25 works on anisotropy of the inner core (it seems that there is quite a few missed) performed in the last 15 years and some others. All of them without exception show that the acoustic properties of the boundary layer of the inner core differ from the similar properties of deeper layers of the inner core and from the properties of the outer core. Similar situation takes place on the core-mantle interface.

4. The model of geomagnetic field generation

Most of the modern models of the geomagnetic field generation origin in the principle of the dynamo-effect. These models apply phenomena occurring at the inner core boundary, that is the F-layer. Here the phase transition from the solid state of the inner core to the liquid one of the outer core take place. It is well known that as generation and separation of the electric charges as the formation the double electric layer follow phase transitions. Also similar phenomena occur at the Earth atmosphere.

Let's use the analogy with phenomena in the atmosphere. It is known that in the Earth's atmosphere the electric charges are continually formed, they separate and recombine. According to the Frenkel's theory, the large water drops have the negative charge and the small water drops have the positive charge. The large drops fall on the Earth (which is well conducting "plate" of the spherical condenser) providing its negative charge. The positive charge accumulates on the other "plate", the conducting ionosphere. If the opposite pattern should observe, that is the hot water bubbles came to the boil and rise over the Earth's surface, transferring the negative to the ionosphere, then the Earth would have the positive charge. Thus, if our suggestion is true, then the change of prevalence of evaporation over condensation would change the polarity of the double electric layer (DEL) "Earth-ionosphere".

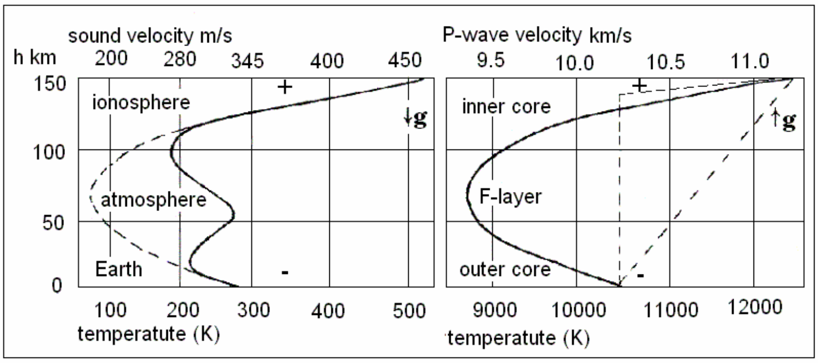

Fig. 3. Sound velocity and seismic P-waves velocity and temperature T: left, at the Earth – ionosphere layer; right, at the F-layer.

Let's imagine that in the F-layer the processes take place analogous to processes in the atmosphere (see Fig. 3). When the dense gaseous matter of the inner G-core (according to Bullen) condense, the large drops accumulate nearly the inner surface of the outer core, which is liquid of the inner core mater. The other way round, during the cycle of evaporation prevalence (during overheating) the boiling bubbles accumulate nearly the inner core boundary. (In our model, as distinct from the situation in the atmosphere, the drops are "more light" than bubbles). In the first case, the F-layer outer boundary becomes negative and the inner boundary is positive; in second case is quite the contrary. Thus, we will consider the F-layer as DEL, in which the change of the phase transition regime leads to change of its polarity.

Let's estimate the electric field intensity E_R in F-layer: $E_R = q/(C'DR)$, here $q = NeV$ is the electric charge of layer, DR is the F-layer thickness, N is the concentration of charge, e is electron charge.

Note that ratio $1/Ne$ is the Hall constant D; V is the volume of spherical condenser:

$$V = 4p\, R^2_G DR,$$

here R_G is the inner core radius. C is the electric capacity of the DEL:

$$C = 4pe_o R^2_G/DR$$

(e_o is the electric constant). We obtain:

$$E_R = DR/(e_o\, D).$$

As pointed out above, the diurnal rotation with frequency ω can cause the appearance of "quasicurrents" and the magnetic field generation. Let's consider this problem in detail. We consider that the positive charge accumulates on one surface of F-layer and the negative charge accumulates on other surface. In the first case, the Hall constant is positive $D^{(+)}$, in the second case it is negative $D^{(-)}$. The change of the DEL polarity changes the sign of E_R (see Fig. 4). The rotation of charges with velocity ω R_G is equivalent to "current" with density $j_w = wR_G/D$. The magnetic field (induction) of such "current" on the axis of system rotation is

$$B_o = m_o j_w\, S_H/2R_G,$$

here S_H is efficient area of the charge concentration: $S_H \approx d'A$, here $d < DR$ (d is the layer thickness and A is layer height in which "current" j_w flows), μ_o is magnetic constant. As the charges at the different boundaries of F-layer have the opposite signs, in such system two currents "flow" in the opposite directions (which are defined by the rotation direction and by the sign of D). In the center of the axial circular "currents" (on the axis of the Earth rotation) the magnetic induction $B = B_G - B_F$, here

$$B_G = m_o\, j_w\, S_H/2R_G, \text{ and } B_F = m_o\, j_w\, S_H/2R_F.$$

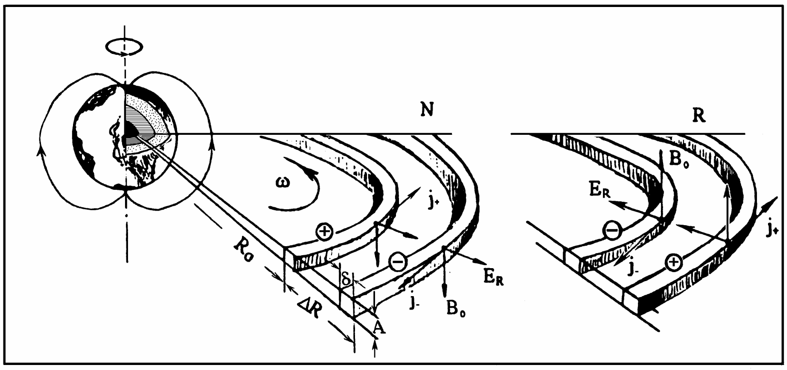

Fig. 4. A double electrical layer on the inner core boundary (at the F-layer), polarity of charges, magnetic and electric fields: at modern polarity of a geomagnetic field - N and at return polarity - R.

Substituting the value $j_w = w\, R_G/D$ into B (in the second case we use R_F instead of R_G), we obtain $B = 0$. However, it is not so for the points which are exterior relatively the current loops. For example, the induction value at equator (horizontal component of field):

$$B^* \approx m_o w S_H DRR_E/h^2 D,$$

here $h = R_E - R_F$, R_E is the Earth's radius. Substituting DR into B, we obtain:

$$B^* = (m_o e_o w/R_E) \times S_X E_R.$$

Substitution of the possible values D ($D = 10^{13}$ m^3/coulomb) leads to value for $E_R = 10^3$ V/m (for comparison, $E = 10^5$ V/m in thunderstorm cloud and $E = 100$ V/m at the Earth surface). Then the value of B^* is determined only the area occupied by the "current": $B^* \approx 10^{-28}\, E_R\, ´ S_H$. Assuming that the value of S_H is around equal to 10^9 m^2, we obtain that magnetic field, arising through the rotation of DEL, is less than required value by factor of 10^{11} (at the equator $B \approx 3\times10^{-5}$ T). This confirms the conclusion made by other authors that it is not possible to ensure the geomagnetic field generation only through the charges separation in DEL.

The dynamo-effect appears to be responsible for the amplification of the magnetic field B* to the required value (about 11 orders of magnitude). This effect is well understood through the development of the models of generation as of the geomagnetic field and as of the dynamo-currents inside ionosphere. Let's consider the model of the ionosphere dynamo (Richbet, Garriot, 1975) as applied to magnetic field generation at the F-layer.

As for ionosphere, the dynamo processes occur at the E-layer, at the height of about 100 km. The equation:

$$m\, d\boldsymbol{V}/dt = e\boldsymbol{E} + e\, \boldsymbol{V} \times \boldsymbol{B} - mn\, (\boldsymbol{V} - \boldsymbol{U}),$$

fit each particle inside the matter under the action of the electric and magnetic fields, here $\boldsymbol{V}$ is the speed of the charged particle, $\boldsymbol{U}$ is the speed of the $e\, \boldsymbol{V}\ ´\ \boldsymbol{B}$. Vector $\boldsymbol{B}$ once directed across the magnetic field lines, induces the field $\boldsymbol{U}\ ´\ \boldsymbol{B}$. This induced field arises the electric current $\boldsymbol{j} \sim s \times \boldsymbol{U}\ ´\ \boldsymbol{B}$, here s is the tensor of conductivity:

$$\sigma = \begin{bmatrix} \sigma_1 & -\sigma_2 & 0 \\ \sigma_2 & \sigma_1 & 0 \\ 0 & 0 & \sigma_o \end{bmatrix}$$

Let's denote the components of the ionosphere conductivity by s_o is a longitudinal component, s_1 is a lateral one, s_2 is a Hall's one, and $s_3 = (s_1^2 + s_2^2)/s_1$ is a Cowling one. The current, arising by the wind transport may not satisfy the condition: *div j* = 0. At the point where in *div j* ≠ 0, the accumulation of the electric charges occur followed by electrically polarized state of ionosphere. The polarizing electrostatic field $ÑF$ (here F is the electrical potential) would arise until the current is horizontal and nondivergental. Under these conditions the layer conductivity s' is determined by the equation:

$$\sigma' = \begin{bmatrix} \sigma_{xx} & \sigma_{xy} \\ -\sigma_{xy} & \sigma_{yy} \end{bmatrix}.$$

The induced and polarization field and together forming the total electric field $\boldsymbol{E}_t$. The current is determined by:

$$\boldsymbol{j} = s'{\scriptstyle x}\boldsymbol{E}_t = s' \cdot (\boldsymbol{U}\ \acute{}\ \boldsymbol{B}\ \textbf{-}\ \tilde{N}\Phi).$$

The ionosphere carries this current at the equator region, in a eastward direction, forming an equatorial current flow, which induce a current flow over the Earth surface in a opposite direction. These both flows were equal in size and opposite signs it the Earth was an ideal conductor and the complications due to the horizontal field variations and to the Earth curvature were ignored (Richbet, Garriot, 1975). The character of the last flow is induction due to the well known Lenz rule.

Let's assume the similar phenomena at the F-layer, namely, there are two opposite in directions currents about 10^{10} amperes is size along the layer. Let's try to relate the anisotropy of the inner core to the morphology of the geomagnetic field in the context of the simplified model of the geomagnetic field, taking into account that the real way of the field generation is more complex.

5. Cylindrical anisotropy

The model of the generation of the geomagnetic field proposes that there is the current scheme looking like a equatorial located thin differential ring at the F-layer. Two opposing currents of order of 10^{10} A flow along A-high and *d*-thick conductors. One of these conductors borders the inner core, and the outer core. The cylindrical anisotropy was detected at the inner core boundary. The velocity of the P-waves within the cylinder is somewhat over than the velocity outside the cylinder, Let's consider if such cylindrical scheme of the geomagnetic field gives rise to the increasing of the velocity of P-waves.

As shown at the right side of the Fig. 3, the increase of the velocity of P-waves of 10% corresponds to the increase of temperature of about 20%. Then our problem would be formulated in the following way: if the cylindrical current dissipative scheme initiates the local heating of about 2-3%. As it is known, the Earth heat flow Q comprises about $3{\cdot}10^{13}$ W, and the intensity of the magnetic field P accounts for 10^{12} W ($Q/P \approx 30$).

Now let's suppose that the heat flow Q relates to the temperature T at the boundary of the inner core: $T \sim P$, and the dissipation of the current scheme provides the additional heating : $DT \sim kP$, here k - a coefficient, that stands for a portion of intensity necessary for the additional heating (ΔT) of the inner core surface portion. ($k < 1$). Here:

$$DT/T = 0{,}02 - 0{,}03,\ T \sim Q/4\pi R^2;\ DT \sim kP/2\pi RA,$$

R - inner core radius, then

$$DT/T = (2kP/Q) \times R/A.$$

Assuming that k is equal to 5%, the ratio of the radius of the inner core R to the cylinder height A, and R/A is evaluated at ≈ 10. Hence it follows that the cylinder height A is approaching 100 km. The additional heating of the height layer A is estimated to be rather strong to provide the required increase of the P-waves velocity.

Let's estimate if the increase of the velocity of the P-waves within the superficial is caused by the additional pressure DP, which is initiated by the exposure of the magnetic field to the current medium:

$$DP = m_o H^2/8p,$$

here m_o is the magnetic constant, H is intensity of the magnetic field (A/m): $H = I/\delta$, δ is the thickness of the layer, related to the initiated additional pressure ΔP. An increase of the velocity of the P-waves of 1% needs the additional pressure of about 10^9 N/m^2.

Then d ($d = [8pDP/m_o\, I^2]^{1/2}$) is required to be about one hundred meters, that is much less than d, deduced from our model. Note, the minimal layer thickness (Adushkin et al., 1997) at which the anisotropy of the inner core is evident, comes out to be units of kilometers. Such magnitude contradictions are not resolved now. It is essential from our model, that it is just the scheme of generation of the geomagnetic field looking like a equatorial located differential current ring at the boundary of the inner core and being responsible for the cylindrical anisotropy of the inner core.

Application of the data of travel-time method to the estimation of A. Let's represent a following process: a seismic ray is moving along by the lateral surface of cylinder A nearly equator. At the absence, of cylindrical anisotropy this ray has the way with the angle of about 150° (see Fig. 5). Now we have the right-angel triangle, with one side A/2 and hypotenuse = $L/2$. The angle at the triangle base a = 150°/2 = 75°. For example, P-wave passes $A/2$ one second quicker than $L/2$. If the wave velocity is 10 km/s, then $L/2 - A/2$ = 10 km, and A ≈ 500 km.

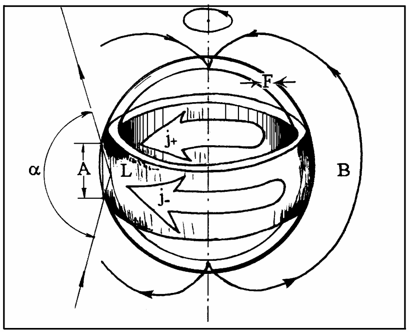

Fig. 5. Cylindrical anisotropy. The seismic ray is deflect by F-layer surface and the ray has angle deflection of $a \approx 150°$. The ray is spread along line A instead of line L.

6. Lateral anisotropy

As noted above, the lateral anisotropy was revealed by travel-time and splitting-function techniques and it is of undoubted interest for gaining an understanding of the Earth inner arrangement (less than a cylindrical one). The P-wave velocities are higher at the inner core regions representing the projections of continents than at these representing the projections of the Pacific and Atlantic oceans. Shows, that nearly the inner core boundary (ICB), the increase of the velocity of P wave is related to reduction of the core radius $v_p \sim 1/R$.

Let's use data on the standard geomagnetic field. The variable part of H component (in mkT) measure at the equator plane. The average of H component at the equator is 32 mkT. Let's resolve the resulting function $H(j)$ into two harmonics. Note, that there is a differential current loop at the equator plane according to our model of the geomagnetic field generation. The symmetry of this ring causes the variable part of H component to fad away.

For example, the displacement of one to another may cause the space variance of H component magnitude, which is seen. As we see, the maximum of H component variance at about 120° E – 135°E, then it need t displace the internal ring in opposite direction to 300 ° E. The magnitude of this displacement x results from proportion: ΔH/H ~ x/ΔR, here x ≈ 1/5 ΔR. Hence, the first harmonics gives the displacement of the internal ring at the equator plane and the second out of roundness.

Let's pay attention to that in the inner core lateral anisotropy, as well as at the second harmonic, two maximums and two minimums are observed. Let's imagine, that this function determines «the second harmonic» decompositions of H component «on eigenfunctions». Then, subtracting it from *H (j)*, we shall receive a function, which (on our model) should show a change of a circle (1), while « the second harmonic » will show a change of the shape of a circle (2). In this case there is no need to displace circles even on 20 km relative to each other, as in a Fig. 6, left, it is enough to deform them a little. In result, in a Fig. 6, right we shall receive a section of a F-layer at a plane of equator, which features the morphology of H component of a geomagnetic field in the best. Thus, the inner core lateral anisotropy appears to play a considerable role in formation of morphology of a geomagnetic field.

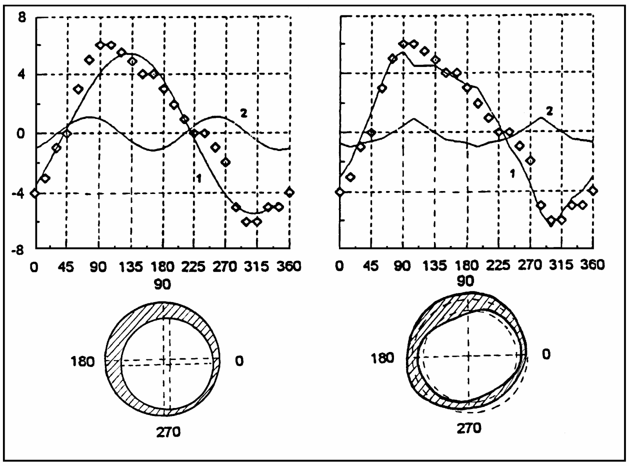

Fig. 6. Lateral anisotropy. A variable part of quantity H component of the geomagnetic field H (φ) in a plane of equator (point): left, the decomposition *H (j)* on the first and second harmonics; below - configuration of a F-layer relevant to decomposition *H (j)*; right, decomposition *H (j)* "on eigenfunctions", one of which (the second harmonic) corresponds the lateral anisotropy of the inner core, " the first harmonic " - to a difference between *H (j)* and second harmonic; below - section of the F-layer.

7. Discussion

Whether it is possible to find a simple and natural explanation to that the shape of a geoid practically iterates the lateral anisotropy of an inner core and mantle? Why the similar pattern is not iterated in an outer core? The answers to these questions are found through the model of "hot" Earth, developed by the author. According to this model, two exothermic phase transitions (PT) take place at the inner core boundary (ICB) and at the outer core - mantle boundary (CMB) there are «condensation - evaporation» in the first case and «crystallization - melting», in second. The substance is condensing through the first PT transmuting so into the substance of the outer core, which is crystallizing at second PT, causing the mantle’s volume to increase (Kuznetsov, 1990; Kuznetsov, 1998). Thus the Earth is expanding. Both PT are interdepended by means of heat transmission through the convecting an outer core. The analysis of splitting-function of outer core, really shows presence 12 of a cellular convection, in it 6 of meshes the substance “falls”, and in 6 others it “rises” (Kuznetsov, 1997). Within our model of the hot Earth, the lateral inhomogeneity of course both “float” shown to be a reason of occurrence of the lateral anisotropy as we found at the inner core and the mantle surfaces. The phase transitions, as at an inner core (at F-layer), and on core-mantle (at D”-layer), occur a little bit more intensively at those regions, which are designed to a day time surface at regions of Pacific and Atlantic oceans. This fact, is related to little bit nonuniform expansion of the Earth in the field of oceans, and has spotted both height of a geoid, and magnification «heights » of an inner core and mantle, producing a diminution of velocity of P-waves at F- and D”-layers. It would seem, this concurrence of the lateral anisotropy at these layers should be repeated and at the occurrence of a cylindrical anisotropy of the mantle, at D”-layer. However it is not really observed. Probably just because the cylindrical anisotropy «owes» to influence of a dissipation, effected by the geomagnetic field generations, inside at the F-layer. Let's pay attention to the fact of the same nonsymmetry of a cylindrical anisotropy and of the morphology of a geomagnetic field about a spin axis. As it was scored above, Creager (1992) biased an axis of an anisotropy by 300° eastward. Selecting most close the morphology of a geomagnetic field to actual one, we as had to bias an interior ring Fig. 4) by 300° eastward too. It was not the only solution, under the comparison of actual morphology of a geomagnetic field with an anisotropy of an inner core. At other solution is shown at a Fig. 4-b, but it is based on some additional information about a source of a geomagnetic field generation. A formal approach to the solution of a problem yields the result of Creager. This fact may be regarded for the benefit of our model. As it was scored, the equatorial section of a F-layer is showed at Fig. 4-b. Discussing our model of geomagnetic field generation and, in particular, formula, we scored, that the parameters ΔR and S_H may appear to be unequal along a surface of a G-core, ensuring a distortion of the shape of the magnetic field (induction) B from rather rotationally symmetric, dipole. Our deductions have confirmed the legitimacy of this supposition. It may be regarded for the benefit of the offered model of the generation of the geomagnetic field, and its correlation with the anisotropy of the inner core.

8. Conclusions

Model of intercorrelation of the inner core anisotropy and the geomagnetic field morphology, is founded on the concepts of the hot Earth and of geomagnetic field generation as the differential current loop at the inner core (at F-layer).

The cylindrical anisotropy of the inner core is showed to be initiated by the dissipation under the generation of the geomagnetic field in response to currents in the F-layer.

It is noted that nonsymmetry of the core cylindrical anisotropy with respect to the axis of rotation correlates with the morphology of the geomagnetic field. Creager (1992) directed anisotropy axis towards 300° E. Analyzing the geomagnetic field morphology, we had to replace the inner ring towards 300° E.

The correlation of the core anisotropy and of geomagnetic field morphology is alternatively solved. The principal sense involves the use of the geometrical variations of the inner core boundary structure along lateral for the construction of the differential current loops (at F-layer).

The data observed at research of the inner core anisotropy were used for the estimation of the height of the differential current loop.

The research on the estimation of nonuniformity of the F-layer thickness *DR* was validated.

The necessity to test conclusions through three dimensional, more complex and adequate to the obtained data model is justified. The design of the geomagnetic field by differential current loop just follows from our hot Earth model. Note, that a similar idea took place at the numerical experiments of Peddie (1979).

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