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SHORT COMMUNICATIONS

Some Features of Twisting of the Earth in Geological History: the Tectonophysical Aspect

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Abstract—In this work some examples of "twisting" of the Earth in the geologic past are given: displacement of the northern parts of the global submeridional structures to the west relative to their southern parts; the rotation of the "geodynamic pair" of Siberia-Laurentia in the Proterozoic; sinistral displacement of the Northern Hemisphere relative to the Southern Hemisphere after the collapse of the last Pangaea; the equatorial rotation of the continental plates; oblique orientation of the global network of planetary fracturing; an inclination of the axis of submeridional compression; sinistral "beveling"; the dextral "twisting" of Venus. All these examples confirm the idea of possible sinistral "twisting" of the Earth that has been proposed by many authors. The cause of such "twisting" is unclear, although it is likely connected with the Earth's rotation around its axis. Some of these examples show that many paleomagnetic reconstructions can be usefully discussed in a tectonophysical aspect. Moreover, in connection with this data, the development of a new scientific field, called *"paleomagnetic tectonophysics"*, is possible.

Keywords: sinistral displacement of the North Hemisphere, the Earth's rotation.

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INTRODUCTION

It has long been observed that the northern parts of global submeridional structures are displaced to the west relative to their southern parts. This refers primarily to four "channel" structures spaced about 90° apart in longitude; these define the "geometrical symmetry of the tectonic plan of the Earth" [Nikishin, Ershov, 2005]), namely the Mid-Atlantic Ridge, the Mid-Indian Ridge, the Western Pacific subduction zone and the East Pacific Rise (if we consider the small Juan de Fuca spreading system as a northern extension of the latter). In addition, North America relative to South America and the northern Atlantic coast of Africa relative to its southern part are characterized by displacement to the west. Such a global structural pattern creates the impression of "twisting" of the Earth; that is, the clockwise movement of the Northern Hemisphere relative to the Southern Hemisphere, when viewed from the North Pole.

If such a relative displacement occurred, then it means, in the tectonophysical aspect, that a geodynamic conditions of sinistral shear movement has been functioning in the Earth's lithosphere. Such a situation could lead to two phenomena, viz., the counterclockwise rotation of large parts of the lithosphere or an appearance of a sinistral shear stress field with a north–east orientation of the axis of maximum compression and a northwestern orientation of the axis of maximum extension.

Without attempting a comprehensive broad generalization, we present some examples from the geological past, showing sinistral shear "twisting" of the Earth relative to the axis of its rotation.

ROTATION OF "GEODYNAMIC PAIR" OF SIBERIA–LAURENTIA IN PROTEROZOIC

As a result of the last paleomagnetic reconstruction, which was carried out by one of the authors

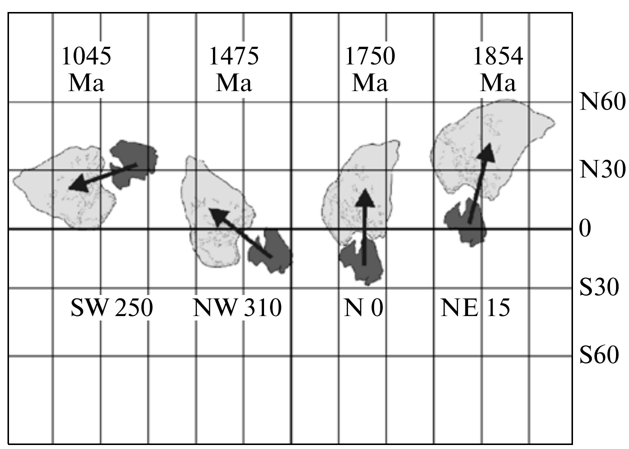

Fig. 1. Paleomagnetic reconstruction of the latitudinal location of Siberia and Laurentia in the Proterozoic after [Vodovozov, 2010]. An azimuth of the relative position of cratons is indicated for every time moment. The average velocity of the relatively uniform counterclockwise rotation of this vector for three subsequent time intervals is 0.14, 0.18, and 0.14, respectively (0.15 degrees per million years on average).

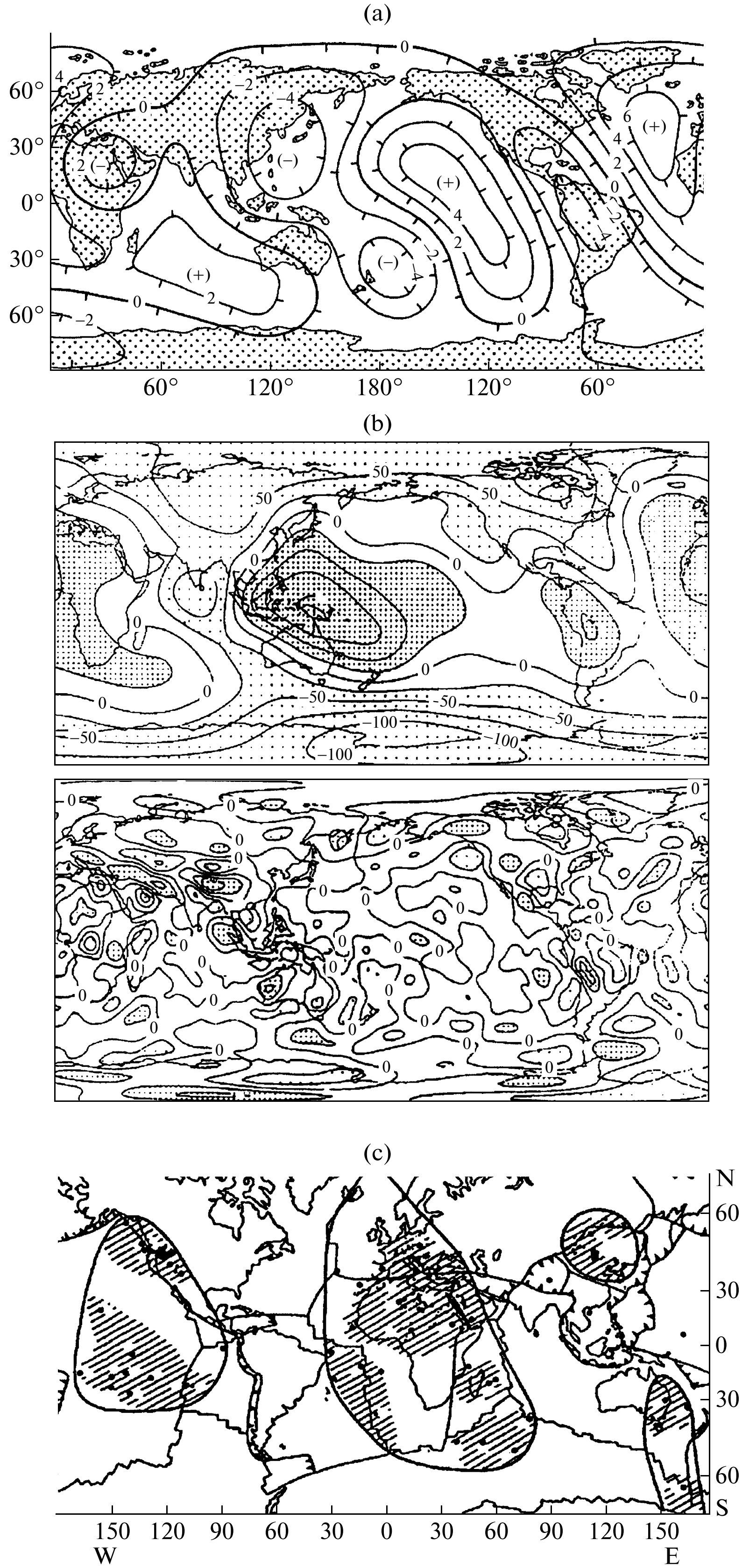

Fig. 2. Sinistral *beveling* of rises and depressions on the Earth's core surface after [Khain, Lomize, 2005] (a); the pattern of positive and negative anomalies of the geoid (the higher approximation degree is at the bottom) after [*Problemy*..., 2000] (b); hot spots on the Earth's surface after [Lobkovsky et al., 2004] (c).

[Vodovozov, 2010] of the drift of the Siberia and Laurentia cratons located in the near-equatorial zone in the Proterozoic (Fig. 1) the counterclockwise uniform rotation of this "geodynamic pair" was established in the period of 1854–1045 Ma.

SINISTRAL DISPLACEMENT OF THE NORTHERN HEMISPHERE RELATIVE TO THE SOUTHERN HEMISPHERE AFTER THE COLLAPSE OF THE LAST PANGAEA

This is reflected in the fact that, according to paleogeodynamic reconstructions [Scotese, Golonka, 1993], Antarctida (the South Pole area) did not rotate after the collapse of the last Pangaea, while the assembly of Eurasia–North America (the North Pole area) experienced a 45° clockwise turn around the Pole.

THE ROTATION OF THE NEAR-EQUATORIAL CONTINENTAL PLATES

At the same time, according to the above reconstructions, Africa was in the equatorial zone and it experienced a counterclockwise rotation by about 30°. An analysis of the structural paragenesises [Kopp, 1997] showed that in modern times a rotation of the Arabian and Hindustan indenters occurred in the same direction.

THE OBLIQUE ORIENTATION OF THE GLOBAL NETWORK OF PLANETARY FRACTURING

The idea of a predominant global orthogonal (meridional and latitudinal) orientation of a regmatic network of faults and fractures is common. Recently, it was defined more precisely that submeridional lineaments are characterized by a middle northeast strike of 10° and sublatitudinal lineaments by 80° [Anokhin, Odessky, 2001]. However, the conjugate Riedel shear zones of R and R' at sinistral shear movement along the Earth's latitudes, caused by sinistral "twisting" of the Earth must have such a strike.

DEVIATION OF THE AXIS OF SUBMERIDIONAL COMPRESSION

There are grounds to think that the Southern Hemisphere expanded in Phanerozoic, and the Northern Hemisphere was reduced as a result of the drift of the Earth's core toward the North Pole [Barkin, 2005; Goncharov, 2007]. Indeed, in the Northern Hemisphere there are many signs of submeridional compression of as the oceanic and continental lithosphere [Goncharov et al., 2010]. However, this general trend has specific features. For example, in remote regions (the Kola Peninsula [Zaitsev, 2009] and Western Siberia [Koronovsky et al., 2009]) the axis of submeridional compression in modern times had a north–northeast strike. This deviation from the meridian can also be explained by sinistral "twisting" of the Earth with a northeastern strike of an axis of the compression superimposed on the meridional compression caused by contraction of the Northern Hemisphere.

A sinistral "beveling" is recorded in horsts and depressions on the surface of Earth's core, a pattern of positive and negative anomalies of the geoid, as well hot spots on the Earth's surface (Fig. 2).

DEXTRAL "TWISTING" OF VENUS

Among the other structures, linear belt ridges are distributed on Venus. They have a predominant submeridional trending, except the South-equatorial region, where the north–northwest strike with an average azimuth of northwest 330° is predominant. This fact was interpreted in [Pivchenkova, 2006] as evidence of the dextral "twisting" of Venus. Moreover, if we take the fact that Venus rotates in the opposite direction relative to the Earth's rotation into account, then there seems to be no escaping the conclusion that "twisting" of the planets is connected in some way with rotation around their axis. In addition, if Venus has a maximum of dextral shear movement in the south-equatorial area, then on Earth this maximum is evidently located in the north-equatorial area; that is, the latitudinal axis of maximum displacement is removed to the north of the equator. This pattern is typical for all four global "channel" structures of the Earth mentioned above. Perhaps it is connected in some way with the northern drift of the Earth's core, extension of the Southern Hemisphere, and contraction of the Northern Hemisphere.

CONCLUSIONS

The above examples support the possible sinistral "twisting" of the Earth suggested by many authors. The cause of such rotation is still under discussion. It can be due to the combination of the northern drift of the Earth's core with the differential rotation of the mantle layers around the Earth's axis [Barkin, 2007], a different velocity of rotation of the Northern and Southern Hemispheres around the Earth's axis [Marcus, 2004], or a general tendency of galactic matter towards vortex twisting [Vikulin, 2008]. At the same time, some of these examples show that many paleomagnetic reconstructions can be usefully considered in the tectonophysical aspect, which may lead to the development of a new scientific field, named "paleomagnetic tectonophysics."

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