The Relationship of Physical Processes in the Space by the Sun and Their Manifestation in the Lithosphere

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Abstract. The multiannual geological, geomechanical and astrophysical studies have proved the periodic expansion and compression of our Galaxy’s stars, the Sun and the Earth. This phenomenon can be the most informative observed on the Earth over millions of years. Over the last 28 years it has been found that there is the changing of the relative deformation and stress state of the Earth's crust in the Ural underground mines and proved that this is the influence of astrophysical processes in space, and the relative deformation $\varepsilon_{AF}$ is numerically common to other regions of the Earth. It has been established that in relative units the radii of the Earth and the Sun vary synchronously and by the same amount. Therefore, the Solar constant and the gravitational constant on Earth are not constant, but change in relative units by the same magnitudes. At extreme values of time variables of stress, catastrophic destruction of ground and underground structures occurs. The situation will escalate by 2020-2024.

1. Introduction
Penetrating into the depths of space, astronomers receive information about events that are currently taking place in the solar system and occurred millions and billions of years ago. Based on the obtained data, astrophysicists theoretically describe physical processes in space and make a forecast of their development. But when describing these processes, researchers do not see their beginning and end, information comes in with gaps in the millions and billions of years, so errors and contradictions are inevitable.

On Earth, assuming the general pattern of its birth and death, it is possible to trace in detail critical and catastrophic conditions not dangerous for the planet itself, but very dangerous for its intelligent inhabitants, leading to repeated partial or complete extinctions of all life. It must be admitted that the creation of catastrophic situations on Earth is mainly the influence of space processes [1].

2. Relevance, scientific significance of the issue with a brief review of the literature
The evolution of the earth is inextricably linked with its periodic expansion and contraction. In his review article on this issue, E.E. Milanovsky (1984) provides such information [2]:

1. A number of researchers believe that the radius of the Earth $R_z$ over the past 3500 million years has increased 1.5-2 times, over 1600 million years - 1.5 times, and over 250 million years - 5-10%. In his work V.E. Khain shows that for 5-20 million years $R_z$ can vary by 1-3% or more.
2. The hypothesis of the pulsation of the Earth against the background of general expansion was expressed by V. Bucher (1933), V.A. Obruchev (1940), M.A. Usov (1940), M.M. Tetyaev (1934), P.N. Kropotkin (1970), N.E. Martyanov (1968), V.E. Khain (1973) [3].

3. The phases of rifting (stretching) do not coincide with the folding phases (compression), although according to the hypothesis of moblism they should coincide, but alternate in time, that is, there is a ripple in the size of the Earth [4].

4. Pulsation cycles: more than 3500 million years - protogee; 3500-1600 Ma - deuterogey; 1600-200 million years - neo-hero; 200 million years - post-Neogee, the beginning of the megacycle; cycles of endogenous activity lasting 40-50 million years were noted by Kunin and Sadovnikov (1976), Maximov et al. (1977), Pronin (1969), where one half is the folding phase and the other half is an increase in rifting; cycles millions of years, thousands of years, several years, etc. [5].

The relative deformation of the Earth's crust (rock mass) as an elastic medium with fixation of tension - compression can be studied on:

- at depths of more than 500 m., i.e. outside (below) the zone of near-surface disintegration of the massif (Bsh - basis in the mine = 50 ÷ 200 m. we measure by the method of flexible filaments or a range finder).

- at bases of 5 - 10 km and more with the Sazhen rangefinders or by conducting tacheometric and leveling moves (Bp - the basis on the surface at a length of 1 ÷ 10 km is measured by a range finder or GPS, GLANASS).

- At the bases of hundreds and thousands of kilometers. (BAS - If the chord AB = 800000 m., Then around the circumference 800120.74 m., At the speed of light 299792458 m / s this ∆ will give 400 n.s. in time.

The physical processes taking place on the Sun, in the Earth and their manifestations in the form of deformations, measured and calculated by generally accepted methods, do not coincide [6]. To bring them to agreement, it is necessary to introduce correction factors. It has been established that the periods of deformation of the Sun and the Earth coincide in time, and the deformation of lithospheric and oceanic plates is the same in magnitude according to GPS data, i.e. the ε measured by us with the equality Eoken and Ekont (E is the dynamic modulus of elasticity) is the same for the entire Earth.

As a result of experimental measurements at the mines of the Urals and Siberia at depths of more than 400 m, i.e. below the disintegration zone of the rock mass caused by alternating shifts in violations, a change in the relative deformation of the rock mass for the period from 1990 to the present, which reached εАФ = -2.0 • 10^{-4} [7], was established.

3. Statement of the problem, theoretical part, practical experiment

Since 1998, with the support of the RFBR grant 98-05-6452, regular special experiments have begun to determine the astrophysical stresses \( \sigma_{\Phi} \) in the Northern, Middle and Southern Urals in the underground mines of the cities of Krasnoturinsk, Nizhny Tagil, Berezovsky and Gai at depths of 600 m, respectively 460 m, 712 m, 512 m and 830 m. For this purpose, differently oriented observational reference lines at bases of 30-50 m were installed in boreholes outside the mining influence zone. The readings were taken 2-4 times a year with an accuracy of tenths, mm Observations over 10 years have shown that the horizontal ntr in the orthogonal directions change by the same amount; later, the average on values shown in the graph were used in the analysis (Fig. 1).

There was a desire to connect these unusual results with already known physical phenomena. Attention was drawn to the solar activity of SA, which is described by two characteristics (Fig. 2):

- spot formation, estimated Wolf number \( W \) and observed regularly since 1600, which began Galileo;
- solar constant estimated by radiation of solar energy

\[ \text{So, Bm} / \text{m}^2, \text{and } \frac{\text{Ro}}{2k} = \text{So}, \text{where } k = 255 \text{ km} / \text{Bm} / \text{m}^2 [5] \text{ related to the radius of the sun Ro.} \]

The radius of the Sun has been measured instrumentally from satellites since 1978. From 1978 to 1600, reconstruction was carried out using \( W \), and from 2010 a forecast was made.
The resulting changes $\sigma_{\text{min}}$ fits well into the schedule $S_0$. The maximum $S_0$ corresponds to the minimum $\sigma_{\text{min}}$ (minimum compression of the array), and the minimum $S_0$ corresponds to the maximum compression of the Earth's crust.

It is of interest to find confirmation of the deformations of the periodic expansion and contraction of the rock mass (Earth) in the analysis of other data.

For this, it is advisable to use the numerous results of measuring natural stresses obtained over the past 40 years. In the ideal case, to determine $\sigma_{\text{min}}$, it is necessary to analyze the results of stress mea-

### Table 1. Results of determination of $\sigma_{\text{AF}}$ from measurements of initial stresses at mineral deposits.

| № | City, field          | date measurements year        | $H$, m | Measured | Averages. $0.5(\sigma_x^n - \sigma_y^v)$ | $\Delta\sigma_{\text{AF}}$ |
|---|----------------------|-------------------------------|--------|----------|---------------------------------------|-----------------------------|
| 1 | Severouralsk         | 1997                          | 490*   | -54      | -33,0                                 | -25,0                       | -44                          | -55                         | >7                          |
| 2 | Krasnoturins k.      | 1968                          | 300    | -10,3    | -7,9                                  | -9,0                        | -9,1                         | -15,1                       | >5,2                        |
|   | Severo-Peschanskoe   | 1984                          | 500*   | -21,1    | -17,6                                 | -19,3                       | -19,3                        | >16,5                       | >14,2                       |
|   | Uchaly               | 1994                          | 550    | -38,5    | -37,4                                 | -38,0                       | -40,5                        | >12,5                       | >5,5                        |
|   | Uzelgin              | 1996                          | 550    | -36,7    | -25,7                                 | -20,3                       | -20,5                        | >17,2                       | >16,0                       |
|   | Abakan               | 1995                          | 265    | -32,9    | -28,1                                 | -30,4                       | -30,6                        | >22,0                       | >21,1                       |
|   | Australia**          | 1976                          | 570    | -15,9    | -21,0                                 | -20,5                       | -20,0                        | >32,0                       | >31,1                       |

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surements obtained: in one field, where horizontal stresses increase with depth by $\Delta \lambda \gamma H$; in massifs of rocks with close elastic characteristics; at depths of more than 150-200 m, where there is no discharge to the weathering zones; at a certain time. The technique for processing such results consists in bringing the horizontal stresses to the selected depth. For example, at the Severo peschanskaya mine (Krasnoturinsk), measurements were made in 1968 ($H = 300$ and $H = 380$ m), 1982 ($H = 430$ m), 1984 ($H = 500$ m) and 1988 g. ($N = 540$ m) [6]. We present the results of measuring stresses to $N = 500$ m according to

$$\sigma_\gamma = 0.5(\sigma_1^{II} + \sigma_3^{II}) + (H_{изм} - H_{500})\lambda \gamma$$

(1)

We assume that the following stresses acted at the Severo peschanskaya mine in the indicated years at a depth of 500 m provided $\lambda \gamma = 0.03$ (Table 1).

There was an opportunity to trace the relative deformation of the massif during the study of the displacement of massifs at the Severo peschanskaya mine, where more than 20 differently oriented reference lines were equipped.

The graph of $\Delta \varepsilon_{AF}$ changes and the astrophysical component of natural stresses $\Delta \sigma_{AF}$ changes are shown together with the graphs of changes in solar radiation $S_0$ and changes in the intensity of galactic cosmic rays in% in Figure 1.

4. Conclusions

For decades, there has been a coincidence in time of the extrema of the intensity of cosmic rays, the radiation energy of the sun and the astrophysical characteristics of the stress-strain state of the earth’s crust, which indicates the unified nature of the physical processes that caused them in space.

![Figure 1](image-url)
The results obtained in published works [11, 12, 13,14,15,16] suggest directions of research and it is necessary to conduct them on a large scale, since the change in the size of the Earth and the accompanying change in the stress-strain state of the rock mass (Earth’s crust) величину $\sigma_{AF}$ is the cause of natural and man-made disasters.

The main danger of $\sigma_{m}$ impact on the structure erected in the rock massif is as follows. Typically, a concrete and reinforced concrete structure is formed in an already prepared space (a canyon under the dam of a hydroelectric power station and a mine working), and when the temperature changes, it fully accepts the load:

- with an increase in $\sigma_{m}$, the structure can be crushed;
- with a decrease in $\sigma_{m}$, the structure can be torn as a result of those increases in the size of the "cavity";
- Over the decades, the capital structure is experiencing several cycles of expansion and contraction of the Earth of varying intensity.

The periods of maximum VAT of the rock mass are characterized by the destruction of elements of high-altitude dams of hydroelectric power stations, the destruction and flooding of underground mines, the sudden release of gas and coal in mines, resulting in the deaths of hundreds of miners.

5. The discussion of the results

The report of the President of the Russian Academy of Sciences A. Sergeev Russian President Putin V.V. as a significant scientific achievement it was said that the rapprochement of the Aleutian and Kamchatka island arcs over a period of 200 years occurs at an average speed of 20 mm / year [9].

For the period we are monitoring for the period 2002-2010, active compression of the Earth's crust basis between Kamchatka and the Commander Islands is 200 km. At this speed of convergence, according to GPS data, it was supposed to decrease by 20 mm or 0.2 meters. Consequently, the relative deformation of the array, which corresponds to a change in stresses in the Earth's crust (with elastic modulus $0.8 \cdot 10^{5}$ MPa and $\mu = 0.26$).

$$\Delta \sigma = \varepsilon \cdot E / (1 - 2\mu) = 1 \cdot 10^{-6} \cdot 0.8 \cdot 10^{5} / 0.48 = 20 \text{ MPa}$$

According to our experimental data, this basis should have decreased by $\Delta \sigma = E_{GPS} \cdot \varepsilon_{AF} = 20000 \cdot 1.2 \cdot 10^{-4} = 24 \text{ m}$, and the stresses in the lithosphere should have changed by $\Delta \sigma = 1.2 \cdot 10^{-1} \cdot 0.8 \cdot 10^{5} / 0.48 = 20 \text{ MPa}$. With such a change in stresses, we can already talk about the trigger mechanism of earthquakes off the eastern coast of Kamchatka.

The natural stress state of the Earth mass is formed in accordance with the physical law as the sum of the components of the gravitational $\sigma_{m}$, tectonic $\sigma_{t}$ and astrophysical $\sigma_{AF}$.

As a result of the influence of astrophysical factors, the size of the earth will decrease by $(0.01 \div 0.05)\%$ by 2020 - 2040, which will lead to an increase in stresses in underground structures of all regions of the world, as a result of which, due to the destruction of mine workings, access to mineral resources at depths greater than 500 m will be extremely difficult or even impossible. This will require changes in mining technology, including phased conservation of deep horizons from the bottom up for the next 30-50 years.

References
[1] Zubkov A V 2010 Patterns of formation of the stress-strain state of the crust of the Urals in time Lithosphere 1 pp 84-93
[2] Milanovsky E E 1984 Development and current state of the problem of Earth expansion and pulsation Problems of Earth expansion and pulsation (M.: Science) pp 8-24
[3] Zubkov A V 2015 Patterns of formation of the stress state of the rock mass in the upper part of the earth's crust Lithosphere 6 pp 116-129
[4] Afanasyev S L 1998 Atlas of time variations of natural, anthropogenic and social processes Cyclic dynamics in nature and society (M.: Scientific world) T 1 pp 88-94
[5] Abdusamatov Kh I 2013 The global minimum of the solar radiation power will lead to a short ice age (SPb.: Nestor-History Publishing) 246 p
[6] Borisenkov E P 1988 The Millennial Chronicle of Unusual Phenomena of Nature (M.: Thought) 522 p
[7] Zubkov A V 2016 The law of formation of the natural stress state of the earth's crust *Lithosphere* 5 pp 146-151
[8] Website PMODWRC https://www.pmodwrc.ch/forschung-entwicklung/solarphysik/tsi-composite
[9] Website of the Moscow Observatory http://cr0.izmiran.ru/mosc
[10] Kozhurin A I 2014 The rate of collision deformations of the Kamchatka Peninsula (Kamchatka) *Geotectonics* 2 pp 42-60
[11] Chongyuan Zhang, Qunce Chen, Xianghui Qin, Bo Hong, Wen Meng, Quanfeng Zhang 2018 In-situ stress and fracture characterization of a candidate repository for spent nuclear fuel in Gansu, northwestern China *Engineering Geology* vol 231 pp 218-229
[12] Shuai Yin, Wenlong Ding, Wen Zhou, Yuming Shan, Runcheng Xie, Chunhua Guo, Xiangyu Cao, Ruyue Wang, Xinghua Wang 2017 In situ stress field evaluation of deep marine tight sandstone oil reservoir A case study of Silurian strata in northern Tazhong area, Tarim Basin, NW China *Marine and Petroleum Geology* vol 80 pp 49-69
[13] Cheuk Yiu Lai, Louis Ngai Yuen Wong, Mark Wallace 2019 Review and assessment of In-situ rock stress in Hong Kong for territory-wide geological domains and depth profiling *Engineering Geology* 248 pp 267-282
[14] Obrzud R F, Truty A 2018 The Hardening Soil model A practical guidebook
[15] Truty A, Obrzud R 2015 Improved formulation of the hardening soil model in the context of modeling the undrained behavior of cohesive soils *Studia Geotechica et Mechanica* vol 37 2 pp 61-68
[16] Wang W D, Li Q, Xu Z H 2017 Determination of parameters for hardening soil small strain model of Shanghai clay and its application in deep excavations (Seoul) pp 2065-2068

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