International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 8(A); August 2018; Page No. 14580-14587
DOI: http://dx.doi.org/10.24327/ijcar.2018.14587.2649

Research Article

HEAT OF THE EARTH AND RADIOACTIVE SUBSTANCES: GENERAL PATTERNS

Khavroshkin O.B and Tsyplakov V. V

IPhE RAS

ARTICLE INFO

Article History:

Received 04th May, 2018
Received in revised form 16th June, 2018 Accepted 25th July, 2018
Published online 28th August, 2018

ABSTRACT

The Earth's thermal fields and temperature fields of radioactive substances have a common periodicity, determined by the cyclical of solar processes and, accordingly, the latent periodicity of neutrino solar fluxes. Temperature variations of all types are determined by anomalous neutrino radioisotope (ANRI) absorption or by the effect of neutrino flux interaction with radioactive structures of the Earth. The statement that the influence of the cyclical of solar activity can be neglected below the zone of constant temperatures (at depths above 40 m), and the temperature regime of the rocks is determined by the depth flow of heat and the specific features of the thermal properties of the rocks, incorrectly: at a depth of 40 m there can exist a thermal component due to muons (K_p-index), and at any and large depths - heat from the interaction of the solar neutrino flux with radioactive structures. When estimating the heat flux, it is necessary to introduce the factor S (ω), which represents the spectrum of the natural oscillations of the Sun. Perhaps there is a relationship between global warming and the heat fluxes of the Earth, taking into account the ANRI effect. New unknown data on long-period wave processes on the Sun are also obtained.

INTRODUCTION

The problems of the Earth's heat and possible connections with other processes become more and more urgent [1-7]. The earth loses about 0.06 watts per square meter of surface, or about 30 trillion watts for the entire planet, from the heat flow from the interior. From the Sun the Earth receives energy approximately 4 thousand times more. Therefore, solar heat plays a major role in establishing the temperature on the earth's surface. However, the power of the entire heat flow of the planet's interior is approximately 30 times greater than that of all modern power plants in the world. For the conduction model of thermal conductivity, the amount of transmitted heat is equal to the product of the temperature gradient (the rate of temperature increase with depth) for thermal conductivity. A heat flow map for the entire surface of the planet is very important. The points in which the heat flux measurements have already been measured are extremely unevenly distributed over the Earth's surface. On the seas and oceans, measurements are made twice as much as not onshore. North America, Europe and Australia, the oceans in the middle latitudes have been studied quite fully. And in the remaining areas of the earth's surface there are still few or no measurements at all. And yet, the current volume of data on the heat flux of the Earth already allows us to build generalized, but sufficiently reliable maps. The heat output from the Earth's interior to the surface occurs unevenly. The cold zone falls on Eastern Europe (the Eastern European Platform), Canada (the Canadian Shield), North Africa, Australia, South America, the deep-water basins of the Pacific, Indian and Atlantic Oceans. "Warm" and "hot" spots - areas of increased heat flow - fall on the regions of California, Alpine Europe, Iceland, the Red Sea, the East Pacific uplift, the underwater mid-ranges of the Atlantic and Indian oceans. Such features of the temperature field are determined by the distribution of heat sources in the depths of the Earth.

The rate of increase in temperature with depth is called a geothermal gradient. The second geothermal quantity, which can be determined experimentally, is the heat flux from the earth's interior. The sources of heat inside the earth, creating a modern heat flow and relatively high temperatures in the bowels of the Earth, according to modern concepts are long-lived and short-lived radioactive isotopes. The energy of radioactive decay is estimated by the heat release in the Earth per unit mass, equal to $4 \cdot 10^{-8}$ (cal / g year). At present, the Earth is in a stationary state - it loses as much heat as it is formed due to radioactive decay. The thermal regime of the deep interior of the Earth causes the existence of global anomalies of the Earth, manifested in the gravitational and magnetic fields. Accumulation and then periodic removal of portions of deep heat dramatically change not only the rheological properties, but also the volume, density and magnetization of rocks due to their melting and transition to an amorphous state. Then the physical properties in the subsequent crystallization stages of rocks change. The study of the heat flux of the Earth is of great importance for solving the

---

Corresponding author*: **Khavroshkin O.B
IPhE RAS

applied and theoretical problems of geology. For example, the analysis of the energy state of the lithosphere, clarifying the nature of geophysical anomalies, the forecast of earthquakes, the study of the conditions for the formation of mineral deposits, etc. Almost all endogenous processes known at the present time are accompanied by the release or absorption of heat, which makes the thermal field a universal indicator of geological phenomena and associated physical fields. Examples of the distribution of the density of heat flux, temperature, the structure of the earth's crust according to deep seismic sounding (DGS), and the geo electric section according to the magnetic telluric sounding (MTZ) data are given below.fig.1.

The thermal balance of the Earth is the balance of the energy of the processes of heat transfer and radiation in the atmosphere and on the surface of the Earth. The main inflow of energy into the atmosphere-earth system is provided by the radiation of the Sun in the spectral range from 0.1 to 4 µm. The density of energy flow from the Sun at a distance of 1 astronomical unit is about 1367 W / m² (solar constant). According to data for 2000-2004, this flux averaged over time and over the surface of the Earth is 341 W / m², or 1.74 • 10^{17} W, calculated on the total Earth surface.

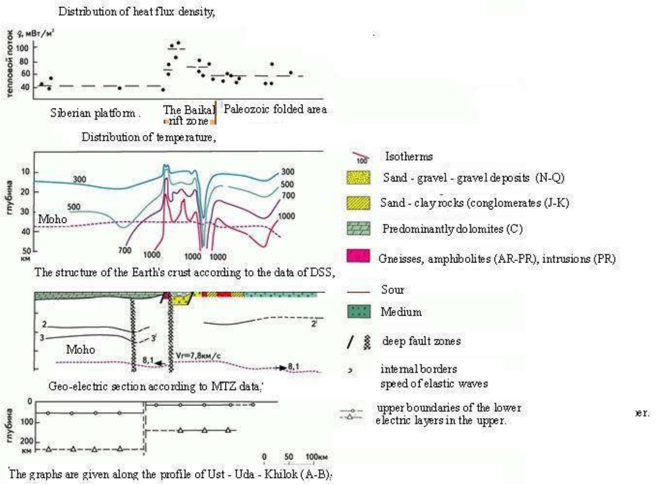
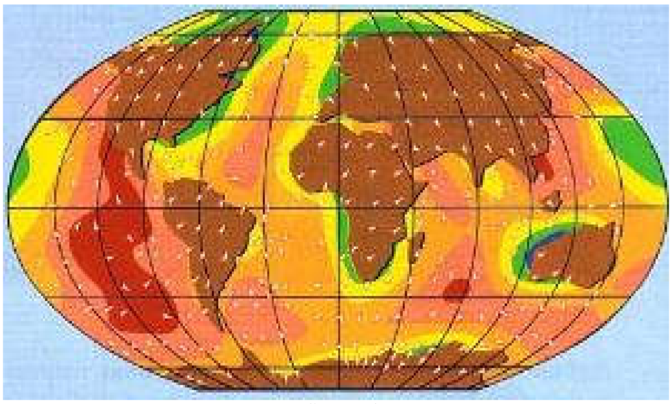


Fig 1 Examples of the distribution of the density of heat flux, temperature, the structure of the earth's crust according to deep seismic sounding (DGS), and the geo electric section according to the magnetic telluric sounding (MTZ) data.

The main sources of the Earth's internal heat are: the decay of long-lived radioactive isotopes (uranium-235 and uranium-238, thorium-232, potassium-40), gravitational differentiation of matter, tidal friction, metamorphism, phase transitions[1]. The average heat flux density over the globe is 87 ± 2 mW / m² or (4.42 ± 0.10) • 10^{13} W in the Earth as a whole [2], that is, about 5,000 times less than the average solar radiation. In oceanic areas, this figure averages 101 ± 2 mW / m², in continental - 65 ± 2 mW / m² [3]. In deep oceanic troughs, it varies between 28-65 mW / m², on continental shields - 29-49 mW / m², in the areas of geosynclines and mid-ocean ridges can reach 100-300 mW / m² or more [4]. About 60% of the heat flow (2.75 × 1013 W) falls on internal heat sources [5], the remaining 40% are due to the cooling of the planet. According to neutrino flux measurements from the Earth's interior, radioactive decay accounts for 24 TW (2.4 × 10^{13} W) of internal heat [6]. The thermal energy of these sources released on the earth's surface per unit time is much higher than the energy of tectonic, seismic and hydrothermal processes. Of particular interest is the deep heat of the planet. According to Alexandre Forte of the University of Western Ontario and Jerry Mitrovic from the University of Toronto in Canada, huge continent-sized hot rocks (plumes) slowly rising from the deep earth's interior are the true driving force for continental drift, earthquakes, volcanic eruptions and even climate change (Fig. 2). Presented in the framework of the mathematical model, the heat flux emerging from the mantle and the speed of movement of the continents and the bottom of the oceans coincided with the results of observations.



Heat flow, 1 / m2

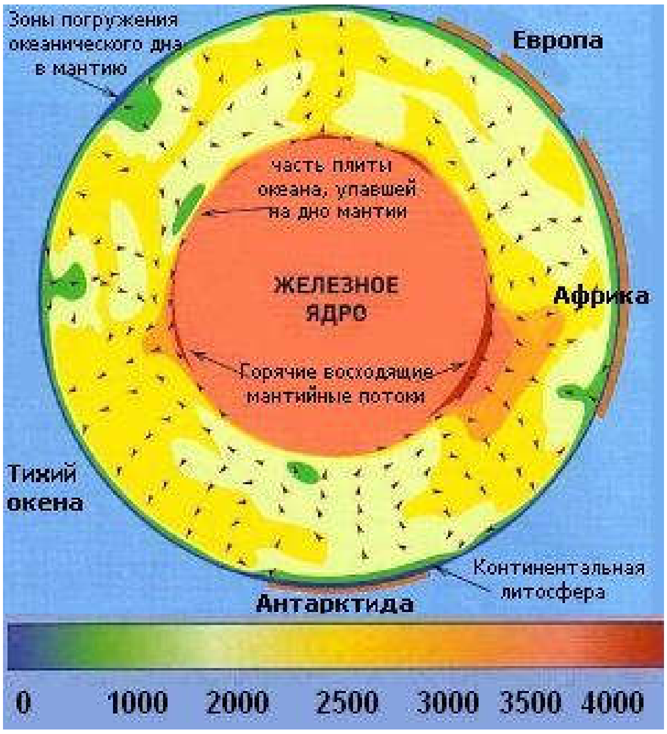


Fig 2 Modern representation of the thermal portrait of the Earth

It is assumed that below the zone of constant temperatures (at depths above 40 m), the influence of the cyclist of solar activity can be neglected, and the temperature regime of the rocks is determined by the depth flow of heat and the specific features of the thermal properties of rocks. The formula for calculating the vertical heat flux (V.K. Khmelevskaya, 1988):

$$q_z = -\lambda_T \frac{dT}{dz} + \sigma \cdot c \cdot V_z \cdot T$$

(1)

Where: $\frac{dT}{dz} \approx \Gamma$ - temperature gradient; λ_T — coefficient of thermal conductivity; σ - density; c-the heat capacity; V_z - vertical convection velocity. In rocky rocks, as well as under steady-state heat transfer, convection can be neglected ($V_z = 0$), and the heat flux density $q_z = -\lambda_T\Gamma$, i. e., it is determined only by the thermal conductivity of the rocks and the temperature gradient. Thus, the regional heat flux of the Earth can be calculated through measured at different depths of temperature and thermal properties of the medium, mainly thermalconductivity.

In geophysics, it is assumed that there must be close ties between the distribution of heat fluxes and other geophysical fields. They are based, on the one hand, on the sensitivity of these fields to fluctuations in the physical parameters of rocks, which are determined by their litho logic - petro graphic features, mineralogical composition and nature of occurrence, and on the other - on the dependence of these parameters on the temperature varying in accordance with the value of the heat flux.

Heat flows of the Earth and solar neutrinos. As it follows from the Introduction, by now geophysics has established the position that the heat fluxes of the Earth are sufficiently well studied, including the most diverse regions, are stable in their deepest part and can have strong regional differences. However, with the discovery of anomalous neutrino radioisotope (ANRI) absorption and the conduct of a research cycle [8-16], it became clear that this provision requires a certain correction. More specifically, this follows from [17]. Indeed, it is known that the spectrum of temporal variations in the activity of a sample of the Trans- baikalian radioactive ore contains peaks that coincide with periods of the Sun's own oscillations. The heavy radioactive deformed nucleus at the pre-decay time increases by many orders of magnitude and is able to interact with the flux of solar neutrinos, which are modulated by the Sun's own oscillations. Further work determined the findings of such a study as the ANRI absorption. To study these effects, as well as a wider application of these radiometric fields, one can use the measurement of the heat fluxes of radioactive elements and their compounds as sources of radiation. That is, it is possible to implement a radiometer on heat fluxes, which will give identical information about the temporal variations of the activity of the sources. Such an instrument is analogous to the ionization calorimeter used in the study of cosmic rays and elementary particles in accelerator experiments. It is shown that the spectrum of long-period oscillations of the Earth exceeding their own contains peaks that coincide in value with an accuracy of 1 ... 3% with peaks of the Sun's own oscillations [8]. The mechanism of excitation of such vibrations and variations a radioactive sample the activity of ore have one nature but a strong difference in scale have practically one nature. The observed effects, together with other periodicities, underlie the interaction in the Earth-Sun systems [11, 12] and affect the volcanism, seismicity and energy of seismic fields [13]. Naturally, variations in solar neutrino fluxes with subsequent changes in radioactive substance activity are accompanied by temporary variations of temperature fields everywhere. Taking into account earlier and recognized studies on neutron fluxes of other authors, we can conclude that not only neutrons but neutrino fluxes appear at all levels of impact on the Earth (crust, mantle, nuclei). That is, the registration of neutrinos in certain processes and sources is accompanied by background noise. In conclusion, we will present the simplest scheme of a radiometer on heat fluxes (RHF) (Fig. 3).

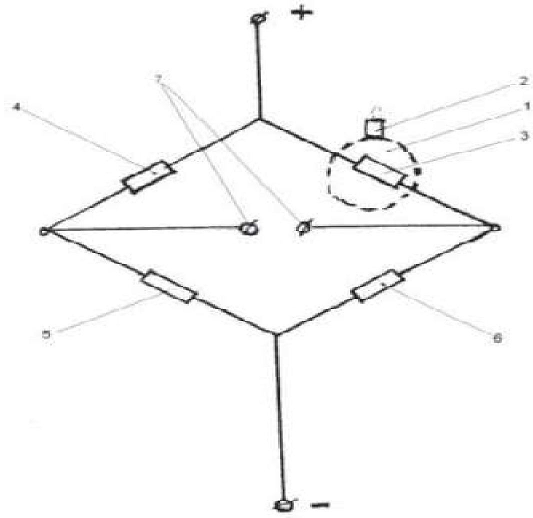


Fig 3 Principal (bridge) scheme of the radiometer on heat flows (RTP): 1 - radioisotope mass; 2 - classical radiometer; 3 - calibrated thermician resistor; 4 ... 6 - the resistors calibrated with respect to the thermister 3; 7 - output of a useful signal.

These conclusions still do not have an immediate character, and some are purely speculative. Therefore, a series of experiments was carried out, directly relating to the behavior of the thermal fields under the conditions of the ANRI effect. Since laboratory samples of radioactive substances as well as heat fluxes of the Earth are exposed to solar neutrinos, in anticipation of the peculiarities of their response, the recording was conducted along several channel, one of the channels was a time series of K_p indices. Specific observations were made of the temperature variations in the valley of the Yellowstone volcano geysers (point 6036940) in comparison with the temperature variations of Cs137, the radioactivity of uranium ore and the CR by indices. Observations of temperature in the valley of the Yellowstone volcano geysers in the creek (point 6036940) were conducted from January 2010 to the present. Fig. 4 shows the temperature variations. Yellowstone volcano was chosen both because of its scale, and the completeness of the geophysical data characterizing its activity.

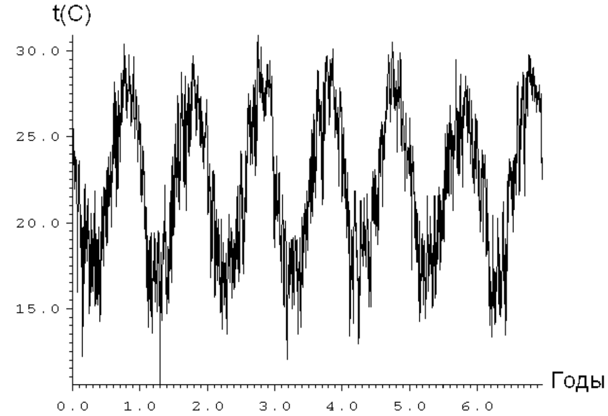


Fig 4 Temperature variations in the valley of the Yellowstone volcano geysers in the creek (point 6036940). Annual, weekly and diurnal variations are observed.

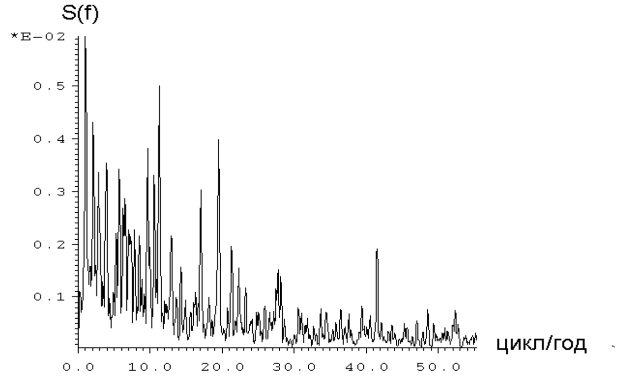


Fig 5 Spectrum of temperature variation in the valley of geysers (point 6036940), Fig.4.

The most significant (P = 0.99) spectral peaks of temperature variations (Fig.5) are presentedinTable1.

Table 1 Spectral peaks of temperature variations in the Yellowstone valley of geysers.

N	Period (days)	Conversion factor	Period (min)	Note: the period's ownership, its features
1	365			1year – Earth rotation
2	178	1456	175.9	NSO g16, l3
3	132	1430	132.9	NSO g8,l2
4	93.1	1460	91.8	NSO g7, l3
5	64.0	1479	62.29	NSO p1,l0
6	37.93	1453	37.58	NSO p2, l1, p1,l4
7	34.7	1351	36,98	NSO p2,l2
8	32.5	1454	32.19	NSO p2,l2
9	28.25	1459	27.88	NSO p3,l1.
10	25.6	1469	25,09	NSO p3,l2
11	21.44	1405	21.97	NSO p3, l4
12	18.79	1448	18.68	NSO p5,l1
13	17.14	1437	17.17	NSO p6, l0
14	16.38	1435	16,44	NSO p5, l3
15	15.69	1437	15.72	NSO p5, l4
16	13.13	1431	13.21	NSO p8, l0
17	8.79	1432	8.84	NSO p12,l1
18	8.06	1452	7.99	NSO p13, l2
19	7.75	1447	7.71	NSO p14, l1
20	7.51	1443	7,49	NSO p14, l2
21	6.98	1459	6.89	NSO p15, l3
22	5.9	1420	5.98	NSO p19, l0
23	5.46	1442	5,45	NSO p20, l2
24	5.26	1443	5,25	NSO p20, l4
25	5.02			
26	4.77			
27	4.53			
28	4.01			
29	3.67			
30	3.49			

The data of Table 1 allow one to assume a multiple connection of the obtained peaks of temperature variations with the natural solar oscillations (NSO), especially since the conversion factor lies in the range of 1470-1420 relative to the registered NSO. Perhaps, it is usually not known by the known equipment over-low-frequency NSO. This result requires a special study.

Further, solar K_p indexes were recorded for 75 days on 22 07 2017y. with a discreteness of 3 hours (Fig. 6). The same sampling was used to obtain the records of Fig. 7-9.

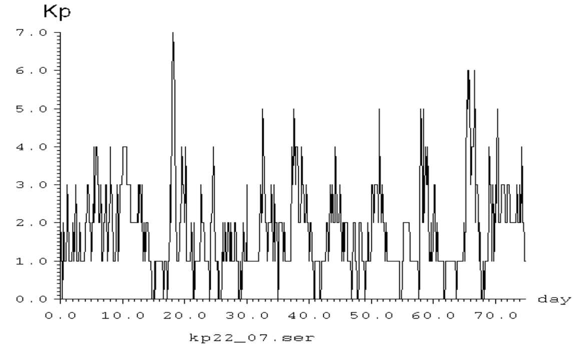


Fig 6 Recording of K_p indices (duration 75days). Since the K_p indices are related to an external effect on the Earth, data on the temperature in the valley of the geysers are also needed (Fig. 7).

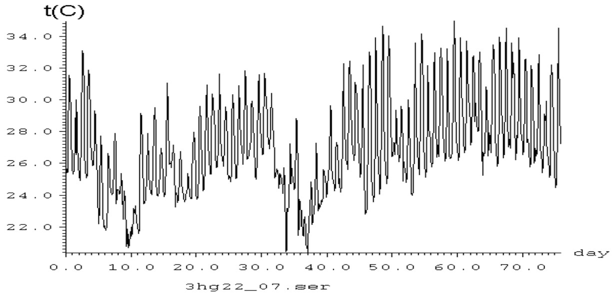


Fig 7 Variations in the temperature in the valley of the geysers near the stream (point 6036940) are also for 75 days. (the time in UT) as well as K_p indices.

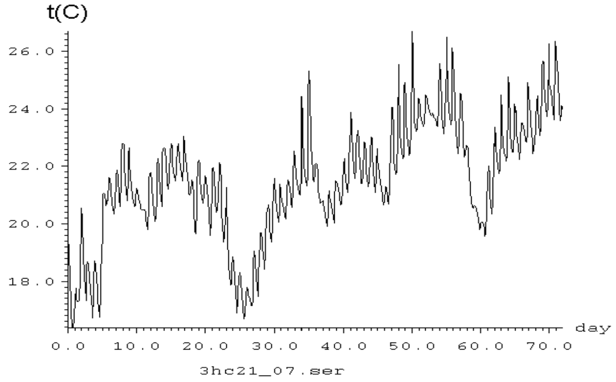


Fig 8 Variations in the temperature of the Cs137 cesium sample for the 72nd day to 21.07. 2017y.

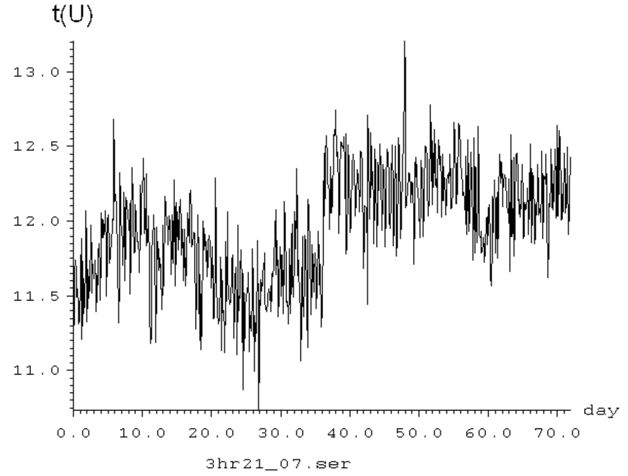


Fig 9 Variation of radioactivity of Transbaikalian uranium ore for 72 days to 21.07.2017y

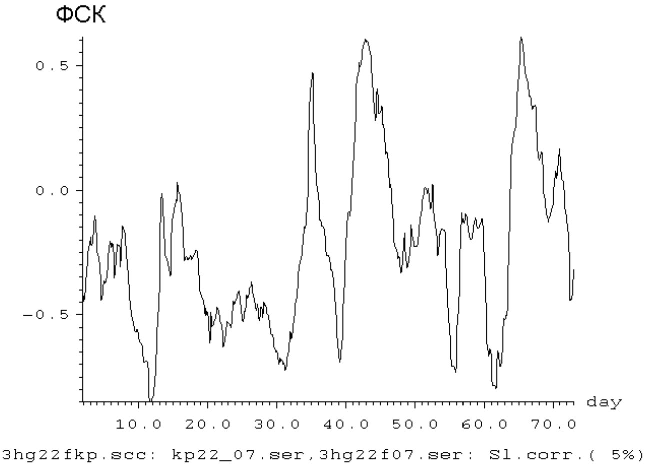


Fig 10 Function of sliding correlation (FSC) between K_p indices (Fig. 6) and temperature variations in the valley of geysers (Fig. 7).

The maximum correlation coefficient (Fig. 10) from K = -0.752 in the 5% window is -0.849 for 10 days to K = + 0.613 for 44 days of the filtered function of the water temperature variations (more than 30 independent points, the significance is P> 0.99). Physically, such a significant correlation positive relationship means that the higher the intensity of solar radiation - the higher the temperature in the stream. The relationship of the same processes, but with negative correlation coefficients, is more complex in interpretation. It is necessary to remember the role of solar muons and neutrinos in the heating of the upper magma chamber of the volcano [11]. In cloudy or rainy weather, these processes can dominate. Further analysis of the data concerned the determination of FSK in a 9% window between K_p indices and temperature variations Cs 137(Fig.11).

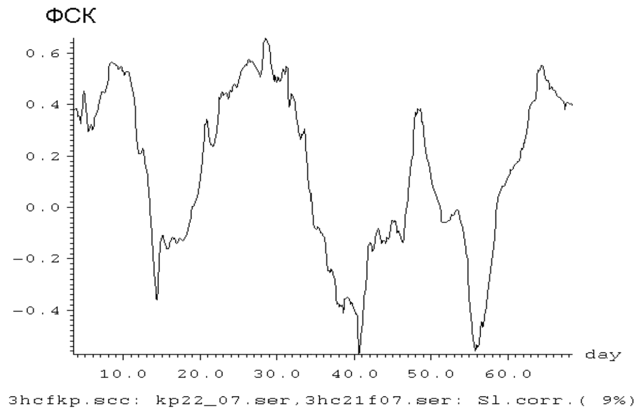


Fig 11 Function of sliding correlation (FSC) between K_p indices and temperature variations Cs 137.

According to Fig. 11, there are significant correlation coefficients as positive K = +0.65 on 10 and 30 days, and negative K = -0.5. Further, FSC was obtained in a 9% window between the temperature variations of Cs 137 (a radiometer on heat fluxes, Fig. 3) and variations in radioactivity of Baikal ore (a standard radiometer), Fig.12.

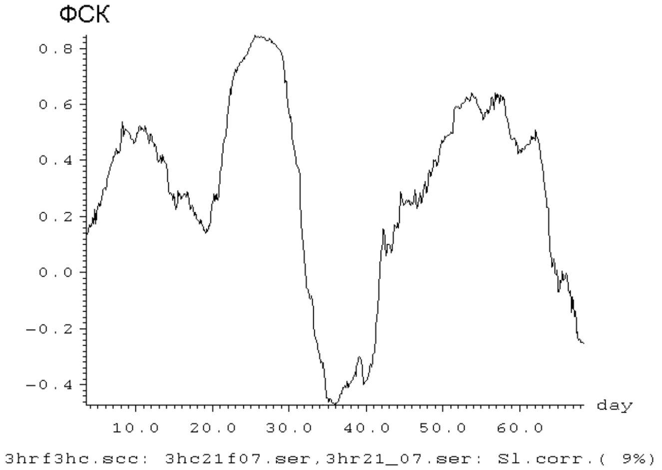


Fig 12 FSC between the temperature variations of sample Cs 137 and variations in radioactivity of Baikal uranium ore.

Next, significant correlation coefficients were obtained as positive. K = +0.85 on days 20 and 30, and negative K = -0.45. Then - FSC in the 9% window between the variations of K_p indices and variations in radioactivity of Baikal ore, Fig. Significant correlation coefficients were obtained as positive K = +0.65 for 30 days, and negative K = -0.45. on 60 days. All these observed results prove the relationship of radioactive processes with solar K_p indices.

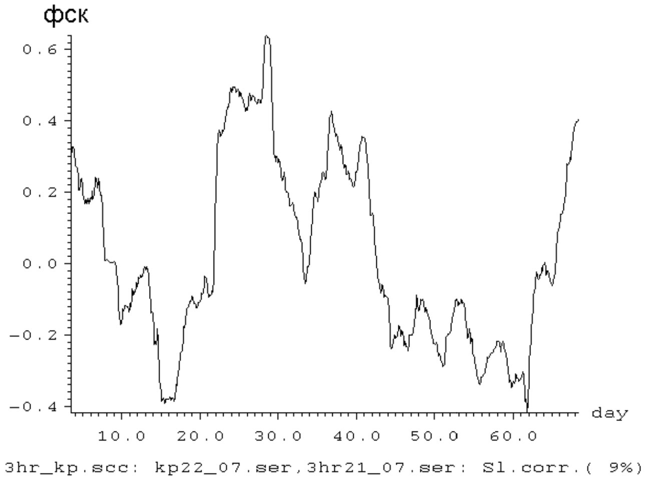


Fig 13 Graph of significant correlation coefficients between variations of K_p indices and variations in radioactivity of Baikal ore.

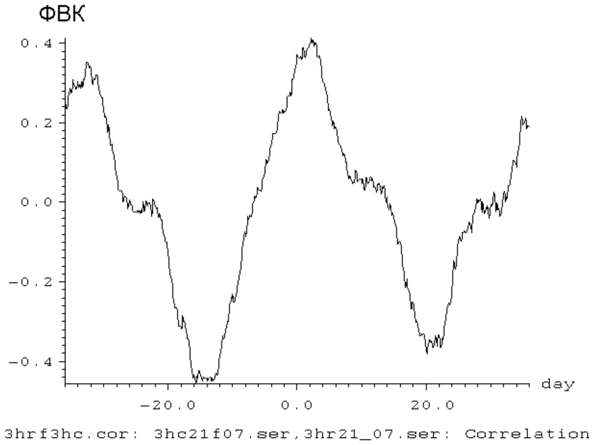


Fig 14 Correlation function between the temperature variations of Cs137 and variations in the radioactivity of Baikal uranium ore.

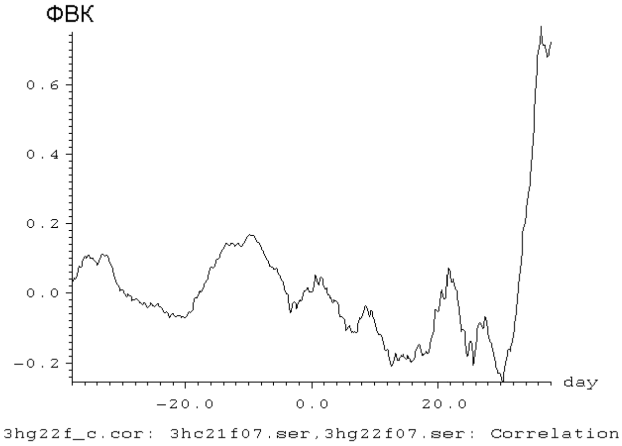


Fig 15 Correlation function between the water temperature variations of the valley of geysers in the stream (point 6036940) (time according to UT) and temperature variations of Cs137

According to Fig. 15, the correlation maximum shifts by 36.5 days relative to the variations in the temperature of cesium 137. That is, the flux of solar neutrinos and muons practically simultaneously affects cesium 137 and the radioactive substances of the magma chambers of the super volcano, but the thermal variations of magma and surrounding structures reach the day surface and origins Creek only after 36.5 days.

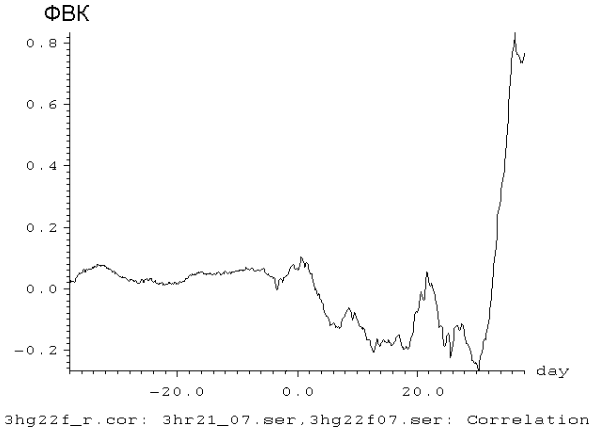


Fig 16 The correlation function between the variations in the water temperature of the valley of the geysers in the creek (point 6036940) (UT time) and the variations in radioactivity of Baikal uranium ore recorded with a 3-hour sampling.

There is also a shift for the same 36.5 days (see above), the maximum correlation of water temperature variations with respect to variations in Baikal ore activity. That is, the same delay mechanism is due to the passage of the thermal variation in the distance of the magma chamber-the day surface. The observed features of the thermal response to the solar neutrino flux were simulated physically.

Physical simulation of the solar neutrino stream effects on the Earth.

The experiment consisted of synchronous observations of temperature variations on Cs137 and Baikal uranium ore under the action of Cs 137 in a lead shell shielding all types of radioactive emissions, except neutrinos, that is, a shell with cesium 137 simulated a laboratory source of neutrinos (Fig. 17, 18).

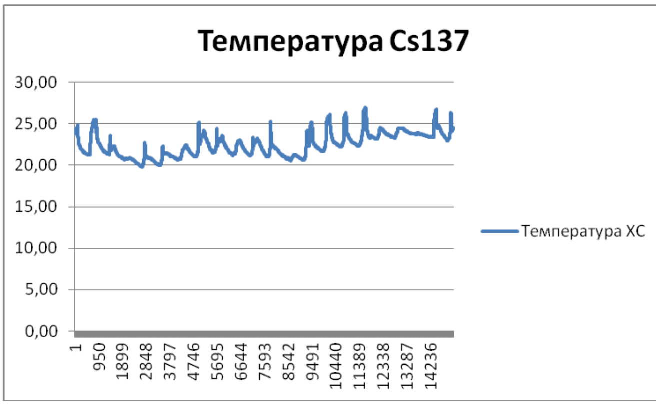


Fig 17 Record the temperature variation Cs137 under the influence of a neutrino source.

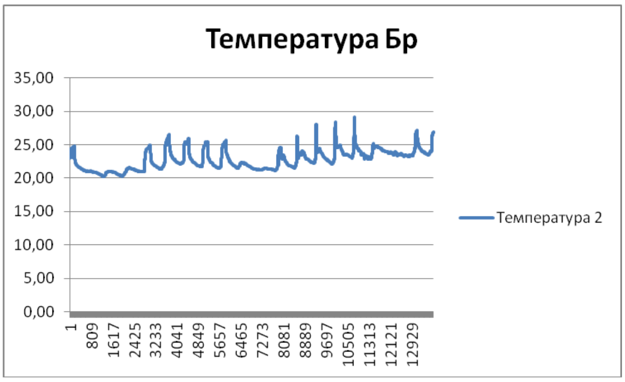


Fig 18 Record the temperature variation of the Baikal uranium ore under the influence of a neutrino source.

Records of the temperature variations of Cs137 and Baikal ore (Fig. 17, 18) were obtained using thermometers of EClerk-USB-2Pt-KI type, registration accuracy - 0.01C0. On these records of temperature variations, diurnal variations are observed, due to day-night thermal changes, including weekly ones. When processing the experimental results, these variations were filtered (deleted).

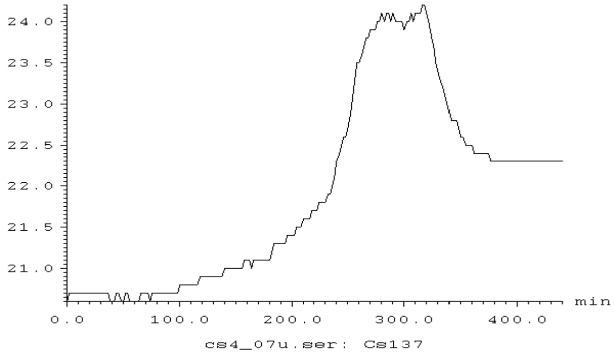


Fig 19 Fragment of recording temperature variations Cs137 (Fig.17)

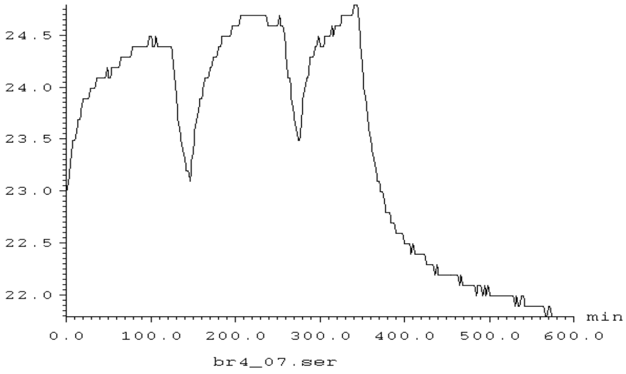


Fig 20 The fragment of the recording the temperature variations of the Baikal uranium ore (Fig.18)

Some analytical estimates

Designations: Bq - becquerel, unit of decay of radioactive substance;

Cs137-radioactive isotope; t_e is the exposure time (exposure);

When exposed to a neutrino source (Cs137 in a lead shell 10 mm thick) on Cs137 and Baikal ore, the exposure time t_e was: for Cs137-1000sec, for ore-1h. According to Fig. 19, 20 the temperature increased by about 2° C.

Let us estimate the temperature effect of neutrinos. $E_{warm} = C_{137} \times m \times \Delta t\ K^0 \times S$;

let: the mass = 1g. = 10^{-3} kg, Specific heat $Cs_{137} = 0.2424$ J / K, for 1000s $\Delta t\ K^0 = 1^0C = 10^{-3}K$, S = 1 cm.

The following is the formula: $E_{warm} = Cs_{137} \times m \times \Delta t \times K^0 \times S = 0.2424 \times 10^{-3} \times 10^{-3} \times 10^{-2} \sim 2.42 \times 10^{-9}J$.

For 1000s, the energy of the incident neutrinos is 1 cm^2 E_n = 10J, and the ratio $E_{warm} / E_n = 2.42 \times 10^{-10}$. This ratio exceeds by more than 2 the previous value obtained with the torsional pendulum $E_n / E_n = 1.26 \times 10^{-10}$. Let's calculate how much cesium has heated up due to additional irradiation of 20000Bq. We assume that the heat capacity is C_{137} = 0.2424J / K, the time of action is Δt = 1000 s.

1Bk = [1MeV = 1.6×10^{-13}J, r = 2cm, S = 1 cm].

$E_n = C_{137} \times 20000Bq / 4\pi r^2 \times \Delta t \times S \sim [0.2424 \times 2 \times 10^4 \times 4.0 \times 10^3 \times 1000 \times 1] \sim 1.6 \times 10^{-13} \times 2.4 \times 10^{11} \sim 4 \times 10^{-2}$ J. $\Delta T^0 = E_n / C_{137} \times m \sim 4 \times 10^{-2} / 0.2424 \sim 1.66 \times 10^{-1}\ C^0$.

For Ore, the specific heat of ore C_{spec}- U_{235} = 0.01421 J / grK^0, the exposure time is Δt = 3.600 s, the mass = 1 g = 10^{-3} kg, S = 1 cm, $E_n = C_U \times m \times \Delta t^0 \times S = \{0.01421\ J / gK^0 \times 2 \times 10^4 \times 4.0 \times 10^3 \times 1000 \times 1\} \sim [1.6 \times 10^{-13} \times 2.4 \times 10^{11}] \sim 4 \times 10^{-2}$ J.

Over 3.600s. the neutrino energy per 1 cm^2 will be $E_n = 3 \times 10$J, and the ratio $E_{warm} / E_n = 2.42 \times 10^{-10}$. This ratio exceeds by more than 2 the previous value obtained with the torsional pendulum En / En = 1.26×10^{-10}. Calculate how much the ore has heated up due to additional irradiation 20000Bq. Assuming: the heat capacity of $C_{specific}$ (U_{235}) = 0.01421 J / gK^0, the exposure time is Δt = 3600 s. [1Bk = 1MeV = 1.6×10^{-13}J, r = 2cm, S = 1 cm], we have the following expression: = $C_U \times 20000Bq / 4\pi r^2 \times \Delta t \times S \sim [0.1\ 421 \times 2 \times 10^4 \times 4.0 \times 10^3 \times 3.600 \times 1] \sim [1.6 \times 10^{-13} \times 1.4 \times 10^{12}] \sim 2.2 \times 10^{-1}$ J. Where $C_U \times m \times \Delta T^0 = E_n \sim 2.2 \times 10^{-1} / 0.1421 \sim 1.5\ C^0$. Thus, when the neutrino is irradiated with 20000Bq for an hour, the temperature should increase by 1.5 C^0, which is observed in the experiment.

CONCLUSION

Even in the first works related to the discovery of the ANRI effect, an assumption was made about the modulation of the heat flux of the Earth on the periods of the Sun's own oscillations [8, 9]. Then seismologists and geophysicists began to observe this periodicity in the structure of seismic fields. But further studies of the relationship between seismic waves and the then-expected variations of thermal fields have not progressed. Self-sufficiency for a special study of the Earth's thermal fields, temperature fields of radioactive substances and the search for general laws were not taken into account. In the present, taking into account the presented studies, we can note the following.

The Earth's thermal fields and temperature fields of radioactive substances have a common periodicity, determined by the cyclist of solar processes and, accordingly, the latent periodicity of neutrino solar fluxes.Temperature variations of all types are determined by the ANRI effect in the interaction of the neutrino flux with radioactive structures of the Earth. Correspondingly, the statement that below the constant temperature zone (at depths over 40 m) the influence of the cyclist of the solar activity can be neglected, and the temperature regime of the rocks is determined by the depth flow of heat and the specific features of the thermal properties of the rocks; incorrectly: at a depth of 40 m there may exist a thermal component at the expense of muons (see Kr-index), at any and large depths, heat from the interaction of the solar neutrino flux with radioactive structures.

Formula (1) for estimating the heat flux must contain a factor S (ω) representing the spectrum of the natural oscillations of the Sun

$$q_z = -\lambda_T \frac{dT}{dz} + \sigma \cdot c \cdot V_z \cdot T \tag{1}$$

The power of nuclear power plants, their prevalence is increasing. Therefore, it should be borne in mind that if ~ 10% of the reactor capacity is an antineutrino flux, the nearest station zone will be a source of increased heat flux and local seismicity and warming. In the case of Japan, a general increase in seismicity is possible.

Since extraterrestrial neutrinos play an important role in the thermal history of the Earth and the safety of nuclear reactors, in the future it is necessary to create an observational network for neutrino safety monitoring.

New long-period oscillations of the solar neutrino flux in the analysis of the thermal field were discovered for the first time.

All of the above allows us to raise the issue of global warming more widely, taking into account new astrophysical processes.

References

1. Kevin E. Trenberth, John T. Fasullo, and Jeffrey Kiehl, March 2009: Earth's global energy budget. - *Bulletin of the American Meteorological Society*, 90, 311–323.
2. Laktionov AG Thermal balance of the Earth / / Physical encyclopedia / Ch. Ed. A. M. Prokhorov. - Moscow: The Great Russian Encyclopedia, 1998. - T. 5. - P. 75-76. - 760 sec. - ISBN 5- 85270-101-7.
3. Geothermic - Mountain encyclopedia.
4. Pollack, H. N., S. J. Hurter, and J. R. Johnson (1993), Heat flow from the Earth's interior: Analysis of the global data set Archive 11 august 2011y., *Rev. Geophys*., 31(3), 267-280.
5. 5.Van Schmus W.R. Natural radioactivity of the crust and mantle, AGU Handbook of Phisical Constants, edited by T.J. Ahrens, Am. Geophys Un., Washington, D.C., 1994.
6. Carol A. Stein Heat Flow of the Earth, AGU Handbook of Phisical Constants, edited by T.J. Ahrens, Am. Geophys Un., Washington, D.C., 1994.
7. Lyubimova E.A. Thermal of the Earth and the Moon. M., 1968
8. Khavroshkin OB, Tsyplakov VV Radioactivity of a sample of ore: monitoring // Engineering Physics. 2013. No. 8. P. 53 ... 62
9. Khavroshkin O., Tsyplakov V. Sun, Earth, radioactive ore: common periodicity. The Natural Science (NS). 2013. Vol. 5. № 9. Pp. 1001…1005.
10. Khavroshkin OB, Tsyplakov VV Anomalous neutrino radioisotope (ANRI) absorption and nuclear reactor // Engineering Physics. 2016. № 10. With. 3 ... 8.
11. Fedotov SA, Khavroshkin OB, Tsyplakov VV, Boyko A.N. Solar and astrophysical factor, Z-variations of GPS data of calderas and volcanoes: the mechanism of their interaction. *Applied Physics and Mathematics*, No. 6, 2016, 57-64.
12. Rukhadze AA, Khavroshkin OB, Tsyplakov VV Periodicity of natural radioactivity // Engineering Physics. 2015. № 6. P. 26 ... 36
13. Nikolaev AV, Khavroshkin OB, Tsyplakov VV Structure of the Strophysical Component of Seismic Emission and Noise // Engineering Physics. 2016. № 9. With. 68 ... 74
14. Karagioz OV, Khavroshkin OB, Tsyplakov VV Torsion scales of Cavendish and Hadron Collider CERN: different fates and results // Engineering Physics. 2016. № 4. With. 3 ... 8
15. Khavroshkin OB, Tsyplakov VV. Yellowstone`s Volcano and Sun: Fragments Selected Works. *Journal of Geology and Geoscience*. Vol. 1(1):2017,pp.5.
16. Khavroshkin O., Tsyplakov V. The Radioactivity of Nuclei & Solar Oscillations: New Experiments. *Natural Science*, 2016, 8, pp.20-32.
17. Khavroshkin ob, tsyplakov vv temperature fields of radioactive substances: temporary variations and applications. *Engineering physics* 2017, No. 7. P.17 ... 31.

How to cite this article:

Khavroshkin O.B and Tsyplakov V. V (2018) 'Heat of THE Earth and Radioactive Substances: General Patterns', *International Journal of Current Advanced Research,* 07(8), pp. 14580-14587.
DOI: http://dx.doi.org/10.24327/ijcar.2018.14587.2649

****