



Research Article

Creation of Fe Isotopes in Natural Geology Crusts as the Result of Self-controlled Global Biostimulated LENR in Oceans and Seas

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Abstract

The paper considers the mechanism of formation of natural iron–manganese crusts, which are located at the bottom of all seas and oceans. These crusts are characterized by a periodic structure and an anomalous ratio of iron isotopes. These anomalies are similar in all seas and oceans and consist in excess of Fe^{54} and Fe^{56} isotope concentration and, accordingly, decrease of Fe^{57} isotope concentration compared to their standard values. It is shown that these anomalies are completely explained by the process of LENR (nuclear transmutation) in the bottom region of the seas and oceans, leading to nuclear fusion with the participation of manganese, sodium, and phosphorus and stimulated by the processes of natural metabolism of microbiological communities.

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1. Introduction

It is traditionally believed that LENR processes can be generated only in specially designed laboratory experiments. Among these processes is the problem of transmutation of isotopes in biological systems, which, in the general opinion, is quite difficult to implement and analyze.

A more detailed analysis has shown that such processes can occur in nature, and their results can directly compete with global geological processes.

The typical example of such global competition can be related to the isotopic anomalies of natural geological Fe–Mn crusts, which are present on most of the coastal areas of all seas and oceans.

It is well known that Fe–Mn crusts are among the most mysterious geological objects. Usually, they occur in sediments of the Eocene-Quaternary age and continue to accumulate at present at depths of 2–5 km, although they

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are also present at substantially lower depths. Their size is from 1 mm to 1 m in diameter, nodules 3–7 cm in size predominate. The total mass of such structures is about 300 billion of tons.

A typical concentrations of metals in these crusts and nodules are the following:

$$\eta_{\text{Mn}} \approx 20 \%, \eta_{\text{Fe}} \approx 15 \%, \eta_{\text{Ni}} \approx 0,5 \%, \eta_{\text{Co}} \approx 0,5 \%, \eta_{\text{Cu}} \approx 0,5 \%.$$

The internal structure of crusts is characterized by a periodical alternation of thin layers of Fe and Mn. The traditional description of such anomalous structures is connected with the possible action of volcanoes. However, such a hypothesis has some problems. First of all, such crusts are found in different places of the Earth and majority of these places are not connected with the volcanic activity. In addition, the strictly periodic structure of such crusts and the approximate constancy of the period, regardless of their location, also confirm that they are not connected with the random activity of volcanoes. It should be noted that there are no consistent data on the age of these structures (there are assumptions about both many millions of years and about an age that is thousands of times less).

Even more mysterious is the violation of the “standard” isotope ratios in all samples of these structures (regardless of their location in all oceans and near the coasts of all continents). In all cases the relative concentration of the Fe^{57} isotope $\eta(\text{Fe}^{57})$ decreases in comparison with concentrations of Fe^{54} and Fe^{56} isotopes $\eta(\text{Fe}^{54})$ and $\eta(\text{Fe}^{56})$ [1].

It is also very important that these objects are always connected with water. It should be noted that usually the standard ratios of main Fe isotopes, determined by their relative concentrations

$$\text{Fe}^{54}(\eta = 5.845\%), \text{Fe}^{56}(\eta = 91.754\%) \text{ and } \text{Fe}^{57}(\eta = 2.119\%) \quad (1)$$

are nearly the same with very high accuracy on Earth and in space (analysis based on meteorites and lunar samples).

Data of ferromanganese crusts samples location and change of normalized $\text{Fe}^{57}/\text{Fe}^{54}$ isotope ratio

$$\delta\text{Fe}^{57}(^0/_{00}) \equiv 1000 \left\{ \frac{\{\eta(\text{Fe}^{57})/\eta(\text{Fe}^{54})\}_{\text{object}}}{\{\eta(\text{Fe}^{57})/\eta(\text{Fe}^{54})\}_{\text{reference}}} - 1 \right\} \quad (2)$$

are presented in Fig.1. Part of these data are presented in Table 1.

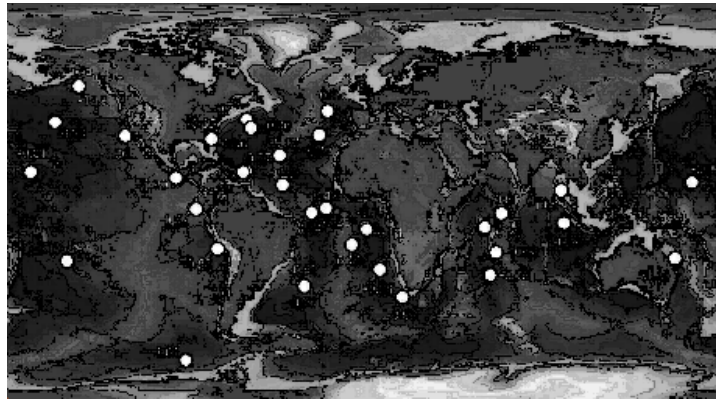


Figure 1. Map of Fe–Mn crust sample location and normalized $\text{Fe}^{57}/\text{Fe}^{54}$ isotope ratio values from each crust [1].

Table 1. Typical isotopic composition of crusts in different oceans [1].

Location	Latitude	Longitude	Water deep (m)	$\delta \text{Fe}^{57} (0/00)$	$\delta \text{Fe}^{57*} (0/00)$
Northwest Atlantic	31° 38' N	78° 40' W	512	–0.85	–0.34
Northwest Atlantic	16° 55' N	61° 10' W	2000	–0.27	–0.10
Northeast Atlantic	32° 36' N	24° 25' W	5347	–0.42	–0.15
Southeast Atlantic	16° 9' S	8° 21' W	1990	–0.27	–0.18
Southwest Atlantic	32° 11,55' S	32° 43' W	3210	–0.95	–0.39
South Atlantic	26° 03' S	5° 42' E	1800	–0.90	–0.26
Indian	7° 20' S	57° 36' E	2421	–0.90	–0.34
Indian	8° 37' N	36° 15' E	449	–1.08	–0.34
Northeast Pacific	32° 15' N	121° 16' W	2267	–1.06	–0.29
Pacific	17° 09' S	75° 15' W	4218	–0.82	–0.28

These data demonstrate a unique and inexplicable result: the ratio of concentrations of $\text{Fe}^{57}/\text{Fe}^{54}$ isotopes in all (without any exception!) geological crusts is significantly less than the same standard ratio. Full data on Fe isotope analysis for all research points in the oceans (Fig. 1) are presented in the work [1].

A similar regularity corresponds to a ratio of Fe^{57} to another Fe^{56} isotope, and in all samples without exceptions a decrease of the normalized $\text{Fe}^{57}/\text{Fe}^{56}$ isotope ratio

$$\delta \text{Fe}^{57*} (0/00) \equiv 1000 \left\{ \frac{\{\eta(\text{Fe}^{57})/(\eta(\text{Fe}^{56}))\}_{\text{object}}}{\{\eta(\text{Fe}^{57})/\eta(\text{Fe}^{56})\}_{\text{reference}}} - 1 \right\} \quad (3)$$

takes place (see Table 1).

These data have shown that the changes in the corresponding isotopic ratios $\text{Fe}^{57}/\text{Fe}^{54}$ and $\text{Fe}^{57}/\text{Fe}^{56}$ have the same tendency, but in all cases the changes for the ratio $\text{Fe}^{57}/\text{Fe}^{54}$ are more significant than for the ratio $\text{Fe}^{57}/\text{Fe}^{56}$.

If we present the relative $\Delta(\text{Fe}^A)$ and absolute $\Delta\eta(\text{Fe}^A)$ change of the concentration $\eta(\text{Fe}^A)_{\text{object}}$ of considered isotopes in the form of the ratio

$$\eta(\text{Fe}^A)_{\text{object}} = \eta(\text{Fe}^A)_{\text{reference}} (1 + \Delta(\text{Fe}^A)) \equiv \eta(\text{Fe}^A)_{\text{reference}} + \Delta\eta(\text{Fe}^A), \quad (4)$$

then the initial formulas (2) and (3) take the form

$$\delta \text{Fe}^{57} (0/00) \equiv 1000 \left\{ \frac{1 + \Delta(\text{Fe}^{57})}{1 + \Delta(\text{Fe}^{54})} - 1 \right\} \approx 1000 \{ \Delta(\text{Fe}^{57}) - \Delta(\text{Fe}^{54}) \}, \quad (5)$$

$$\delta \text{Fe}^{57*} (0/00) \equiv 1000 \left\{ \frac{1 + \Delta(\text{Fe}^{57})}{1 + \Delta(\text{Fe}^{56})} - 1 \right\} \approx 1000 \{ \Delta(\text{Fe}^{57}) - \Delta(\text{Fe}^{56}) \}.$$

In these formulas $\Delta(\text{Fe}^{57}) \leq 0$, $\Delta(\text{Fe}^{54}) \geq 0$, $\Delta(\text{Fe}^{56}) \geq 0$ in accordance with the data of Table 1.

There are no reasonable explanations of these anomalies in the literature using the “standard” physical mechanisms (diffusion, the influence of volcanoes and geysers, gravitational deposition and fractionation, sea currents, etc.).

2. LENR-Mechanism and Biological Stimulation of the Formation of Iron–Manganese Isotopic Anomalies in Marine Geology

There are two possible ways to solve this isotope problem.

The first one (non-realistic) is connected with the assumption of a real decrease of the absolute concentration and absolute mass of the Mössbauer Fe^{57} isotope. However, this hypothesis immediately leads to the questions of the mechanism and causes of the disappearance of this isotope. These questions have no answers.

The second way, according to which the increase of the concentrations (mass density) of Fe^{54} and Fe^{56} isotopes is greater than the increase of Fe^{57} , is much more realistic.

The explanation of the origin of such anomalous structures and abnormal isotope ratios is connected with natural LENR reactions



of nuclear transmutation of Mn^{55} , Na^{23} and P^{31} isotopes dissolved in water into the considered iron isotopes.

The probability of such reactions is negligible if we consider them on the basis of the theory of hot nuclear fusion, for which the probability of a tunnel effect at a typical ocean temperature does not exceed $10^{-200} - 10^{-1000}$. The situation fundamentally changes if we take into account influences on such processes of growing microbiological cultures, which successfully grow in the bottom region of all seas and oceans.

This “fusion pathway” is in a good agreement with the results of our experiments on the efficient fusion of the same iron isotopes at the presence of growing microbiological cultures and chemical elements which are necessary for the growth of microbes and corresponding transmutation of isotopes.

The high probability of reactions (6) in growing microbiological systems is connected, according to our calculations and the results of our experiments [2–5], with the formation of coherent correlated states (CCS) of interacting nuclei [6–16]. It was shown that CCS formation leads to the generation of extremely great fluctuations of kinetic energy of these nuclei. When one of these particles with mass M is localized in non-stationary potential wells of nanoscale with the size a , the energy fluctuation in CCS exceeds the value [8–16]

$$\delta E^{(\min)} \approx G_{pq}^2 \hbar^2 / 2Ma^2 \approx 10 - 100 \text{ keV}. \quad (7)$$

It is very important that such giant fluctuations can exist an anomalously large (compared to the characteristic value

$$\delta t \geq \hbar / 2\delta E \quad (8a)$$

determined from the standard Heisenberg uncertainty relation) time

$$\delta t \geq G_{Et} \hbar / 2\delta E, \quad (8b)$$

that is sufficient for realization of all fusion reactions (6) in the case $G_{Et} \gg 1$ [15].

These results are based on the Schrödinger–Robertson uncertainty relations [17–19] for energy and time

$$\delta E \delta t \geq \frac{\hbar^*}{2}, \quad \hbar^* = \frac{\hbar^*}{\sqrt{1 - r_{Et}^2}} \equiv G_{Et} \hbar, \quad r_{Et} = \frac{\langle \hat{E} \hat{t} + \hat{t} \hat{E} \rangle / 2 - \langle \hat{E} \rangle \langle \hat{t} \rangle}{\sqrt{\langle \hat{E}^2 \rangle \langle \hat{t}^2 \rangle}}, \quad 0 \leq |r_{Et}| \leq 1 \quad (9a)$$

and relations

$$\delta q \delta p \geq \frac{\hbar^*}{2}, \quad \hbar^* = \frac{\hbar^*}{\sqrt{1 - r_{pq}^2}} \equiv G_{pq} \hbar, \quad r_{pq} = \frac{\langle \hat{q} \hat{p} + \hat{p} \hat{q} \rangle / 2 - \langle \hat{q} \rangle \langle \hat{p} \rangle}{\sqrt{\langle \hat{q}^2 \rangle \langle \hat{p}^2 \rangle}}, \quad 0 \leq |r_{pq}| \leq 1 \quad (9b)$$

for momentum p and coordinate q .

Here r_{Et} and r_{pq} are correlation coefficients for corresponding dynamic variables (E , t and q , p) and

$$G_{Et} = 1 / \sqrt{1 - r_{Et}^2} \approx 10^3 - 10^4, \quad G_{pq} = 1 / \sqrt{1 - r_{pq}^2} \approx 10^3 - 10^4$$

are the achievable coefficients of correlation efficiency for the pairs of these variables [8–14]. The method of calculation of the coefficient G_{Et} for the first time was considered in [16].

The process of the formation of such states, as it is shown in the works [6–14], can be realized in any non-stationary potential well on the nanoscale, which correspond to many typical biophysical processes (e.g. cell division region, DNA replication, processes on the surface of plasma biomembranes, etc.).

Due to the constant and very small ($0.014 \pm 0.002\%$) natural ratio of D to H concentrations in water, changes of concentration of created Fe^{56} and Fe^{57} isotopes is always synchronized, but the total probability of transmutation differs greatly. Obviously, the total mass of the synthesized Fe^{57} isotope is nearly in the same time lower than the mass of the synthesized Fe^{56} isotope.

This tendency can explain the decrease of the relative concentration of Fe^{57} isotope ($\Delta(\text{Fe}^{57}) < 0$), which accompanies a simultaneous slight increase of its mass in comparison with a much more significant increase of the mass and concentration of Fe^{56} isotope $\Delta(\text{Fe}^{56}) > 0$.

From the other hand, the effectiveness of such reactions depends on the mass and concentration of manganese, for which the natural concentration in ocean water equals

$\eta(\text{Mn}) \approx 4.39 - 274.7 \text{ ng/kg}$ (average values is $\langle \eta(\text{Mn}) \rangle \approx 207.98 \text{ ng/kg} \approx 0.0002 \text{ ppm}$) [20]. By the way, the natural concentration of iron in ocean water is much less and equal to

$$\eta(\text{Fe}) \approx 1.12 \text{ to } 111.7 \text{ ng/kg and } \langle \eta(\text{Fe}) \rangle \approx 27.9 \text{ ng/kg} \approx 0.000028 \text{ ppm [20].}$$

There are several fundamental circumstances that significantly change this situation. It is well known that different types of microorganisms (e.g. *Oscillatoria terebriformis*) play important role in the natural self-concentration (biological extraction) of certain metals (mainly manganese) from sea water [21–23]. There are a lot of different types of such microbial metallophages. A typical example of such microbes that assimilate the metal and include them in the metabolic process can be seen on the legendary Titanic (Fig. 2), which is located at a depth of 3750 m.

The additional method of increase of the manganese concentration in the area of ??crust formation can be connected with a well-known effect of the biological extraction of manganese from sea water with the help of *Foraminifera* — single-celled shell organisms. After the natural death of these microorganisms, they dissolve in the water column without reaching the bottom. Nowadays, these silts cover at least a quarter of the bottom of the oceans and consist mainly of foraminifera shells of the genus *Globigerina*. In this case, a natural effective accumulation of manganese in the layer of this sludge takes place.



Figure 2. The growth of colonies of microorganisms on the metal parts of the Titanic [24,25].

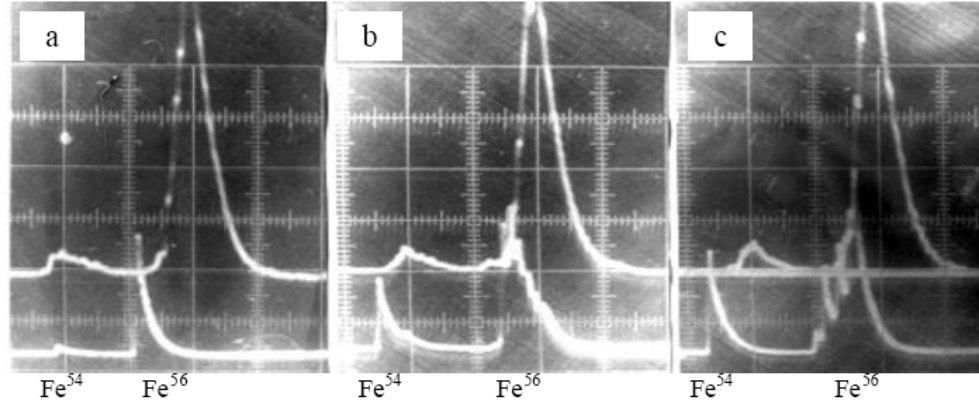


Figure 3. Time-of-flight mass-spectrometric analysis of the results of experiments on isotope Fe^{54} creation in laboratory reaction $\text{Na}^{23} + \text{P}^{31} = \text{Fe}^{54}$: fragments of the mass spectrum of the same bacterial culture *Bacillus subtilis*, grown in a nutrient medium based on H_2O in the presence of Na^{23} and P^{31} , (b), (c) and the absence of P^{31} . (a) The upper graphs on each of the photos correspond to the control spectrum of the natural iron masses obtained in the same series as the corresponding lower graphs. These results were obtained using a time-of-flight mass spectrometer and were displayed on the screen of an oscilloscope with memory.

In contrast to such complicated prehistory of Mn localization and concentration, the efficiency of Fe^{54} fusion (6) depends on the concentration of sodium Na^{23} ($\eta(\text{Na}^{23}) \approx 10.8$ ppm) and phosphorus P^{31} ($\eta(\text{P}^{31}) \approx 0.09$ ppm), which are presented in seawater in significant quantity (much more than Mn^{55}).

The above-listed circumstances show that there are all the necessary prerequisites for the effective transmutation of isotopes in growing microorganisms. The possibility of such transmutations (Na^{23} and P^{31} to Fe^{54} and Mn^{55} to Fe^{37}) has been reliably confirmed in our experiments (see Figs.3 and 4) [2–5].

The effectiveness of such a transmutation processes depends on many circumstances and in the case of a balanced composition of the necessary macro and microelements are the following:

$$\lambda = \frac{\Delta N(\text{Fe}^A)}{N(\text{Mn}^{55})\Delta t} \approx 10^{-8} \text{ synthesized } \text{Fe}^A \text{ nuclei per s and per single } \text{Mn}^{55} \text{ isotope,} \quad (10)$$

$$\lambda = \frac{\Delta N(\text{Fe}^{54})}{N(\text{Na}^{23})\Delta t} = \frac{\Delta N(\text{Fe}^{54})}{N(\text{P}^{31})\Delta t} \approx 10^{-8} \text{ synthesized } \text{Fe}^{54} \text{ nuclei per s and per } (\text{Na}^{23}, \text{P}^{31}) \text{ isotopes}$$

for the case of transmutation with a participation of pure microbiological cultures (similar *E.Coli*) and

$$\lambda = \frac{\Delta N(\text{Fe}^A)}{N(\text{Mn}^{55})\Delta t} \approx \frac{\Delta N(\text{Fe}^{54})}{N(\text{Na}^{23})\Delta t} \approx \frac{\Delta N(\text{Fe}^{54})}{N(\text{P}^{31})\Delta t} 10^{-6} \text{ per s and per } \text{Mn}^{55}, \text{Na}^{23}, \text{P}^{31} \text{ isotopes} \quad (11)$$

using of microbiological syntrophic associations [2–5].

The characteristic feature of such a transmutation is self-limiting and self-control: the process begins to be inhibited when a great amount of toxins (as the result of metabolic processes) are released and when the local environment is depleted with the necessary isotopic components.

Under laboratory conditions, these factors can be controlled and corrected by periodical adding of appropriate chemical components into the liquid “working” environment.

Under natural conditions, a sufficiently long time is needed to re-launch the transmutation process, during which a natural self-purification of the nearest environment from toxins takes place and the necessary isotopic composition is restored.

This process of self-healing of the local environment can be quite lengthy. In nature, it is carried out using reducers – heterotrophic organisms that return the necessary micro and macro elements from dead organisms to inanimate nature. They implement such a process, decomposing organic residues into simple inorganic chemical compounds in the process of their natural activity. The most effective reducers are bacteria.

After restoration of the necessary composition of micro and macronutrients, the process of transmutation of isotopes begins a new cycle.

Such a self-similar process justifies the periodicity of iron synthesis in crust volume and the formation of thin layers of Fe and Mn.

3. Summary

The scenario considered above fully substantiates all the quantitative and qualitative features of the formation of iron–manganese crusts.

If we use the “standard” estimate for the total mass of iron–manganese crusts and nodules on the ocean bottom ($M_{\text{total}} \approx 300$ billions of tons) and take into account the average experimental values for normalized isotope ratios ($\langle \delta\text{Fe}^{57}(0/00) \rangle \approx 0.8$, $\langle \delta\text{Fe}^{57*}(0/00) \rangle \approx 0.25$) and the relative concentration of iron in these structures ($\eta_{\text{Fe}} \approx 15\%$), then the masses of created isotopes that are connected with such a transmutation are very large and are equal to

$$\Delta M(\text{Fe}^{54}) \approx M_{\text{total}} \eta_{\text{Fe}} \eta(\text{Fe}^{54})_{\text{reference}} \langle \Delta(\text{Fe}^{54}) \rangle \approx 4 \times 10^6 \text{ tons of Fe}^{54} \text{ isotope ,} \quad (12)$$

$$\Delta M(\text{Fe}^{56}) \approx M_{\text{total}} \eta_{\text{Fe}} \eta(\text{Fe}^{56})_{\text{reference}} \langle \Delta(\text{Fe}^{56}) \rangle \approx 2 \times 10^7 \text{ tons of Fe}^{56} \text{ isotope .}$$

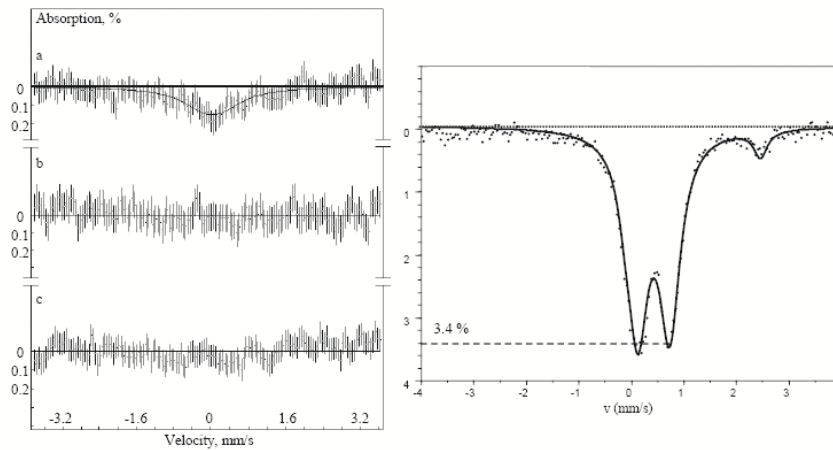


Figure 4. Left: Mössbauer spectrum of the dried microbiological culture of *Saccharomyces cerevisiae* T-8, grown in a liquid nutrient medium based on: (a) heavy water D₂O in the presence of the Mn⁵⁵ isotope; (b) light water H₂O in the presence of Mn⁵⁵; (c) heavy water D₂O in the absence of the Mn⁵⁵ isotope. Right: Mössbauer spectrum of dried microbiological association grown in the volume with presence of D₂O and Mn⁵⁵ isotope.

If we accept that the maximal rate of transmutation of Mn to Fe in natural conditions is close to the values (10) corresponding to transmutation in the laboratory, then the maximal rate of global transmutation in ocean bottom is

$$\Lambda \approx \lambda \frac{M_{\text{total}}}{m(\text{Mn}^{56})} \eta_{\text{Mn}} m(\text{Fe}^{56}) \approx 600 \text{ tons of synthesized Fe}^{56} \text{ isotope per second} \quad (13a)$$

for pure culture and

$$\Lambda \approx \lambda \frac{M_{\text{total}}}{m(\text{Mn}^{56})} \eta_{\text{Mn}} m(\text{Fe}^{56}) \approx 60\,000 \text{ tons of synthesized Fe}^{56} \text{ isotope per second} \quad (13b)$$

for microbiological association.

It is also necessary to take into account that laboratory conditions as a rule are better than natural conditions. On the other hand, it is obvious that the biological substance at the bottom of the oceans roughly corresponds to the microbiological association. Based on these circumstances, we can conclude that a reasonable estimate for the maximal total rate of transmutation is close to the value

$$\Lambda \approx 6000 \text{ tons of synthesized Fe}^{56} \text{ isotope per second.} \quad (13c)$$

This maximal total rate is 100 times higher than the average steel smelting rate worldwide which is equal to 60 tons per second or about 1.8 billions tons per year. Of course, the average rate of transmutation will be several orders of magnitude smaller than this value.

From these results follows that the LENR process based on the transmutation of isotopes in grown biological systems is not limited to the framework of a precision laboratory experiment, but is a significant factor in the geological evolution of the Earth.

In conclusion, one more remark can be made regarding the fundamental problems of the geochemical evolution of the Earth.

It is easy to show that processes, which are close to the results discussed in this paper, can be connected with pulsed stimulation of nuclear reactions due to the action of strong shock waves caused by earthquakes. Such processes, which are connected with cracking of brittle rocks and generation of THz pressure waves, can lead to fission or fusion reactions with formation of new elements and (in selected cases) concomitant neutron emission. These processes have been actively discussed in numerous works (e.g., [26–31]).

In our opinion, the specific physical mechanism of such a stimulation can be connected with traditional piezonuclear reactions [31] and with the discussed process of formation of coherent correlated states of particles located in the region of unsteady deformation [11,13]. Of course, it is impossible to explain the mechanism of formation of iron and manganese periodic layers in the crust volume using such a pulsed random process connected with earthquakes, but in other cases this scenario is quite real. It is very interesting that similar mechanism for stimulation of nuclear fusion has been predicted and implemented in recent experiments on the effects of high-frequency temperature waves on a distant TiD target [32].

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