PROBABLE MICROBIOLOGICAL ORIGIN OF CHEMICAL ELEMENTS IN POLYMETALLIC NODULES ON THE OCEAN FLOOR

Boris A. Andrianov*

Abstract —
A hypothesis is put forward explaining the origin of chemical elements in polymetallic nodules on the ocean bottom as a result of bacteria activity initiating low energy nuclear fusion reactions (LENR). As is known, sea water, bottom deposits and suspensions contain Na, Cl, Ca, K, Mg, Li, Al, Si, B, P, F and S. From this set of elements the formation ways are shown not only for iron and manganese, but also for Ti, Co, Ni, Zn, Cu, Cr, V, Mo, Ga, Ge, Se, Br, Zr, Sr, Y, Nb, In, Sn, Sb, W, Hf, Re, Ag, Pd, Rh, Cd, Sc, Te, Ba, La, Ce, Nd and Sm. The origin of listed elements occurs with the active bacteria participation as a result of heat-generating LENR mainly by electron capture from inner atomic layers without additional external expenditure of energy, any radioactive materials or hard radiation. This allows us to naturally explain the emergence in nodules of stable isotopes of many elements which are really present there.

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Iron-manganese nodules are wonderful and mysterious oceanic formations.[1] They occur everywhere in oceans and cover vast surfaces of the sea floor. As is evident from their name, the prevailing elements of nodules are iron and manganese, the mean relative content of each presenting about 16%.[2] This value exceeds these elements' concentrations in sea water by a hundred million times.[1,Table34] Surpassing values also take place as compared with continents: mean concentration of manganese in nodules almost by 170 times and iron by three times as much as in the Earth crust.

Besides those metals the nodules contain titanium, cobalt, nickel, zinc, copper, chromium, vanadium, molybdenum, bromine, yttrium, zirconium, niobium and other rare elements—more than 40 in all, with concentrations of them considerably exceeding their Clarke numbers. Resources of nodules on the ocean floor boggle the human mind: they are estimated as more than 300 billion tons and increase by 10 million tons annually.[3] The endeavors of researchers to explain the emergence of such great concentrations of manganese and iron in nodules are quite understandable. However, despite a great number of studies on these topics, controversy and uncertainty in many issues remain. Until now, we actually do not know where metals bound in iron-manganese deposits come from, what the mechanism of nodule formation is, their growth rate, etc.[3] Perhaps this situation emerged because all similar explanations were not beyond the scope of usual ideas and did not take into account those natural phenomena and laboratory experiments which would be the key to understanding.

The results of one of those phenomena are the manganese fulgurites searched out in Nebraska in 1924. They were described in an article by Cook.[4] In the restricted area of an acre of land 30 or 40 of these manganese fulgurites were found. The typical fulgurite contained 48.3% of manganese dioxide, 6.7% of ferric oxide and aluminum oxide. There were neither manganese nor iron deposits in that place; fulgurites occurred in the hard, tough, fine-grained, argillaceous sand-rock, to a depth exceeding three feet. The quantity of uncovered fulgurites explicitly demonstrates multiple recurrence of this experiment formulated by nature itself. The protagonist of this experiment was a lightning strike into argillaceous sand-rock which did not contain any manganese or iron theretofore.

It is reasonable to assume that the record concentration of manganese could only appear as a result of nuclear fusion of aluminum and silicon contained in the argillaceous sand-rock[5]:

$$^{27}_{13}\mathrm{Al} + ^{28}_{14}\mathrm{Si} \rightarrow ^{55}_{27}\mathrm{Co}^{*} \xrightarrow{18\ \text{hours}} ^{55}_{26}\mathrm{Fe}^{*} \xrightarrow{2.7\ \text{years}} ^{55}_{25}\mathrm{Mn} + 18\ \mathrm{MeV} \quad (1)$$

(Here and further the energy release was calculated using nucleus ground and isomeric state parameters[6]; almost all figures are rounded to zero decimal places.)

Fusion of $^{27}_{13}\mathrm{Al}$ and $^{28}_{14}\mathrm{Si}$ nuclei occurs in three stages. Initially the radioactive isotope $^{55}_{27}\mathrm{Co}^{*}$ is generated (half-decay period is 18 hours). It is turned by electron capture into a radioactive isotope $^{55}_{26}\mathrm{Fe}^{*}$ (half-decay period is 2.7 years). An atom $^{55}_{26}\mathrm{Fe}^{*}$, in its turn, also executes an electron capture and finally is turned into the single stable $^{55}_{25}\mathrm{Mn}$ isotope.

Another possible fusion reaction with a chain of transformations and resultant formation of iron can occur between equal silicon nuclei[7]:

$$^{28}_{14}\mathrm{Si} + ^{28}_{14}\mathrm{Si} \rightarrow ^{56}_{28}\mathrm{Ni}^{*} + ^{0}_{-1}e \xrightarrow{6\ \text{days}} ^{56}_{27}\mathrm{Co}^{*} + ^{0}_{-1}e \xrightarrow{77\ \text{days}} ^{56}_{26}\mathrm{Fe} + 11\ \mathrm{MeV} \quad (2)$$

Thus, aluminum and silicon are in this argillaceous sand-rock not by accident; they play a major part in manganese and iron formation.

Reaction 2 is supported by a paper[8] which reports on research of Kolyma fulgurite formed as a result of a lightning strike in alluvial argillaceous shale. Metallic spheroids from rare iron-bearing minerals were discovered in it. These iron-comprising minerals are more typical for extraterrestrial objects. They occurred everywhere in the fulgurite and were absent in surrounding rocks, *i.e.* these minerals were not noted by moving away from a central channel. It positively indicates the cause-effect relationship of forming these minerals with lightning discharge.

In the presence of aluminum, iron can also appear as a result of direct fusion of two Al nuclei, as was already experimentally observed by Krymsky.[9]

$$2\,^{27}_{13}\mathrm{Al} \rightarrow ^{54}_{26}\mathrm{Fe} + 22\ \mathrm{MeV} \quad (3)$$

How can the fulgurite formation be pertinent to iron-manganese nodules? A bridge for understanding the connection between these phenomena is concealed in the experiments of Vysotskii and Kornilova.[10] They observed transformation of sodium and phosphorus into iron in growing bacteria culture *bacillus subtilis* (hay bacterium), the growth time being from 24 to 72 hours in different runs without any external force. Experimental results of mass-spectrometric identification (Figure 4.7 of Reference 10) is evidence of clear reaction behavior:

$$ {}^{23}_{11}\text{Na} + {}^{31}_{15}\text{P} \rightarrow {}^{54}_{26}\text{Fe} + 22\text{ MeV} \tag{4} $$

In the products of Reaction 4 a mass spectrometer recorded isotope ^{54}Fe and its concentration relative to isotope ^{56}Fe increased more than four times as compared with the natural value. It is pertinent to note that before Reaction 4 isotope ^{54}Fe was almost absent.

Vysotskii and Kornilova also described (Chapter 4.4.2 of Reference 10) high-performance transformation of ${}^{133}_{55}$Cs into rare barium isotope ${}^{134}_{56}$Ba:

$$ {}^{133}_{56}\text{Cs} + {}^{1}_{1}\text{H} \rightarrow {}^{134}_{57}\text{La}^{*} \xrightarrow{6\text{ min}} {}^{134}_{56}\text{Ba} + 8\text{ MeV} $$

The authors[10] explained the obtained results by introducing the model of transitory dynamic "removal" of Coulomb barrier influence on probability of nuclear fusion, but, whatever the real reason for observation of Reaction 3, for the time being this reaction (and also all the ones mentioned in the present paper) can be *de facto* regarded as a peculiar "black-box" in which input is the left part of reaction and output is the right one.

Geochemical functions of microorganisms have already been studied for many years; the whole family of specific iron-manganese bacteria is even known. However, until now they were assigned the part only in oxidation processes of transformation of ferrous iron into ferric iron and bivalent manganese into its trivalent and tetravalent state; nothing of any LENR appears to have been raised at all. We have to assume that hay bacterium is not unique for its ability to initiate low energy nuclear fusion reactions; apparently, this ability is common to many oceanic microorganisms.

As is known, sea water, bottom deposits and suspensions contain Na, K, Li, B, Mg, Al, Si, Ca, P, S, F and Cl. Deep-water red clay covers vast surfaces of sea floor and contains all these elements. The manganese and iron origin (Reactions 1-4) was already shown. It will be shown below how not only iron and manganese can be created from them but also many other elements existing in the nodules.

Iron

In addition to Reactions 2-4, iron can be formed at silicon and magnesium fusion[11]:

$$ \begin{aligned} {}^{26}_{12}\text{Mg} + {}^{28}_{14}\text{Si} &\rightarrow {}^{54}_{26}\text{Fe} + 19\text{ MeV}; \\ {}^{24}_{12}\text{Mg} + {}^{30}_{14}\text{Si} &\rightarrow {}^{54}_{26}\text{Fe} + 18\text{ MeV}; \\ {}^{25}_{12}\text{Mg} + {}^{29}_{14}\text{Si} &\rightarrow {}^{54}_{26}\text{Fe} + 21\text{ MeV}; \\ {}^{26}_{12}\text{Mg} + {}^{30}_{14}\text{Si} &\rightarrow {}^{56}_{26}\text{Fe} + 20\text{ MeV}. \end{aligned} $$

Titanium

Titanium results from fusion of two sodium nuclei[5]:

$$ {}^{23}_{11}\text{Na} + {}^{23}_{11}\text{Na} \rightarrow {}^{46}_{22}\text{Ti} + 25\text{ MeV} \tag{5} $$

Titanium is also capable of coming into being at LENR interaction of sodium with magnesium isotopes:

$$ \left. \begin{aligned} {}^{23}_{11}\text{Na} + {}^{24}_{12}\text{Mg} &\rightarrow {}^{47}_{23}\text{V}^{*} \xrightarrow{33\text{ min}} {}^{47}_{22}\text{Ti} + 21\text{ MeV}; \\ {}^{23}_{11}\text{Na} + {}^{25}_{12}\text{Mg} &\rightarrow {}^{48}_{23}\text{V}^{*} \xrightarrow{16\text{days}} {}^{48}_{22}\text{Ti} + 25\text{ MeV}; \\ {}^{23}_{11}\text{Na} + {}^{26}_{12}\text{Mg} &\rightarrow {}^{49}_{23}\text{V}^{*} \xrightarrow{330\text{ days}} {}^{49}_{22}\text{Ti} + 22\text{ MeV}. \end{aligned} \right\} \tag{6} $$

If we assume the Mg isotopes ratio in the nodule formation does not differ from the natural one on the Earth core (^{24}Mg – 79%, ^{25}Mg – 10%, ^{26}Mg – 11%)[6] then in the first place among Ti isotopes generated as a result of these reactions there must be ^{46}Ti, followed by ^{47}Ti, ^{49}Ti and ^{48}Ti. This should sharply contrast with natural abundance of Ti isotopes: ^{46}Ti – 8.25%, ^{47}Ti – 7.44%, ^{48}Ti – 73.72%, ^{49}Ti – 5.41%.

Thus, if by a mass spectrometry analysis one can succeed in ascertaining a significant difference from these values, the LENR origin of Ti in nodules can be proved.

Cobalt

A single stable cobalt isotope can be formed in the following reaction:

$$ \begin{aligned} {}^{31}_{15}\text{P} + {}^{28}_{14}\text{Si} &\rightarrow {}^{59}_{29}\text{Cu}^{*} \xrightarrow{82\text{ s}} {}^{59}_{28}\text{Ni}^{*} \xrightarrow{76000\text{years}} {}^{59}_{27}\text{Co} + 15\text{ MeV}; \\ {}^{29}_{14}\text{Si} + {}^{30}_{14}\text{Si} &\rightarrow {}^{59}_{28}\text{Ni}^{*} \xrightarrow{76000\text{years}} {}^{59}_{27}\text{Co} + 15\text{ MeV}. \end{aligned} $$

Nickel

$$ \begin{aligned} {}^{32}_{16}\text{S} + {}^{28}_{14}\text{Si} &\rightarrow {}^{60}_{30}\text{Zn}^{*} \xrightarrow{2\text{min}} {}^{60}_{29}\text{Cu}^{*} \xrightarrow{24\text{min}} {}^{60}_{28}\text{Ni} + 16\text{ MeV}; \\ {}^{33}_{16}\text{S} + {}^{28}_{14}\text{Si} &\rightarrow {}^{61}_{30}\text{Zn}^{*} \xrightarrow{89\text{ s}} {}^{61}_{29}\text{Cu}^{*} \xrightarrow{3\text{ hours}} {}^{61}_{28}\text{Ni} + 15\text{ MeV}; \\ {}^{32}_{16}\text{S} + {}^{29}_{14}\text{Si} &\rightarrow {}^{61}_{30}\text{Zn}^{*} \xrightarrow{89\text{ s}} {}^{61}_{29}\text{Cu}^{*} \xrightarrow{3\text{ hours}} {}^{61}_{28}\text{Ni} + 15\text{ MeV}; \\ {}^{32}_{16}\text{S} + {}^{30}_{14}\text{Si} &\rightarrow {}^{62}_{30}\text{Zn}^{*} \xrightarrow{9\text{ hours}} {}^{62}_{29}\text{Cu}^{*} \xrightarrow{10\text{ min}} {}^{62}_{28}\text{Ni} + 15\text{ MeV}; \\ {}^{31}_{15}\text{P} + {}^{29}_{14}\text{Si} &\rightarrow {}^{60}_{29}\text{Cu}^{*} \xrightarrow{24\text{min}} {}^{60}_{28}\text{Ni} + 18\text{ MeV}; \\ {}^{31}_{15}\text{P} + {}^{30}_{14}\text{Si} &\rightarrow {}^{61}_{29}\text{Cu}^{*} \xrightarrow{3\text{ hours}} {}^{61}_{28}\text{Ni} + 15\text{ MeV}; \\ {}^{23}_{11}\text{Na} + {}^{35}_{17}\text{Cl} &\rightarrow {}^{58}_{28}\text{Ni} + 22\text{ MeV}; \\ {}^{23}_{11}\text{Na} + {}^{37}_{17}\text{Cl} &\rightarrow {}^{60}_{28}\text{Ni} + 23\text{ MeV}; \\ 2\,{}^{29}_{14}\text{Si} &\rightarrow {}^{58}_{28}\text{Ni} + 16\text{ MeV}; \\ {}^{28}_{14}\text{Si} + {}^{30}_{14}\text{Si} &\rightarrow {}^{58}_{28}\text{Ni} + 14\text{ MeV}; \\ 2\,{}^{30}_{14}\text{Si} &\rightarrow {}^{60}_{28}\text{Ni} + 16\text{ MeV}. \end{aligned} $$

Copper

$$ \begin{aligned} {}^{39}_{19}\text{K} + {}^{24}_{12}\text{Mg} &\rightarrow {}^{63}_{31}\text{Ga}^{*} \xrightarrow{32\text{s}} {}^{63}_{30}\text{Zn}^{*} \xrightarrow{38\text{ min}} {}^{63}_{29}\text{Cu} + 17\text{ MeV}; \\ {}^{41}_{19}\text{K} + {}^{24}_{12}\text{Mg} &\rightarrow {}^{65}_{31}\text{Ga}^{*} \xrightarrow{15\text{min}} {}^{65}_{30}\text{Zn}^{*} \xrightarrow{244\text{ days}} {}^{65}_{29}\text{Cu} + 17\text{ MeV}; \\ {}^{40}_{20}\text{Ca} + {}^{25}_{12}\text{Mg} &\rightarrow {}^{65}_{32}\text{Ge}^{*} \xrightarrow{31\text{s}} {}^{65}_{31}\text{Ga}^{*} \xrightarrow{15\text{min}} {}^{65}_{30}\text{Zn}^{*} \xrightarrow{244\text{ days}} {}^{65}_{29}\text{Cu} + 18\text{ MeV}; \\ {}^{62}_{28}\text{Ni} + {}^{1}_{1}\text{H} &\rightarrow {}^{63}_{29}\text{Cu} + 6\text{ MeV}; \\ {}^{64}_{28}\text{Ni} + {}^{1}_{1}\text{H} &\rightarrow {}^{65}_{29}\text{Cu} + 7\text{ MeV}. \end{aligned} $$

Zinc

$$ {}^{39}_{19}\mathrm{K}+{}^{27}_{13}\mathrm{Al} \rightarrow {}^{66}_{32}\mathrm{Ge}^* \xrightarrow{\text{2 hours}} {}^{66}_{31}\mathrm{Ga}^* \xrightarrow{\text{10 hours}} {}^{66}_{30}\mathrm{Zn} + 17\ \mathrm{MeV}; $$

$$ {}^{40}_{20}\mathrm{Ca}+{}^{27}_{13}\mathrm{Al} \rightarrow {}^{67}_{33}\mathrm{As}^* \xrightarrow{\text{43 s}} {}^{67}_{32}\mathrm{Ge}^* \xrightarrow{\text{19 min}} {}^{67}_{31}\mathrm{Ga}^* \xrightarrow{\text{3 days}} {}^{67}_{30}\mathrm{Zn} + 14\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{67}_{32}\mathrm{Ge} \xrightarrow{\text{19 min}} {}^{67}_{31}\mathrm{Ga} \xrightarrow{\text{3 days}} {}^{67}_{30}\mathrm{Zn} + 15\ \mathrm{MeV}; $$

$$ {}^{39}_{19}\mathrm{K}+{}^{28}_{14}\mathrm{Si} \rightarrow {}^{67}_{33}\mathrm{As}^* \xrightarrow{\text{43 s}} {}^{67}_{32}\mathrm{Ge}^* \xrightarrow{\text{19 min}} {}^{67}_{31}\mathrm{Ga}^* \xrightarrow{\text{3 days}} {}^{67}_{30}\mathrm{Zn} + 11\ \mathrm{MeV}; $$

$$ {}^{40}_{20}\mathrm{Ca} + {}^{28}_{14}\mathrm{Si} \rightarrow {}^{68}_{34}\mathrm{Se} \xrightarrow{\text{36 s}} {}^{68}_{33}\mathrm{As} \xrightarrow{\text{152 s}} {}^{68}_{32}\mathrm{Ge} \xrightarrow{\text{271 days}} {}^{68}_{31}\mathrm{Ga} + \xrightarrow{\text{68 min}} {}^{68}_{30}\mathrm{Zn} + 12\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{26}_{12}\mathrm{Mg} \rightarrow {}^{68}_{32}\mathrm{Ge} \xrightarrow{\text{271 days}} {}^{68}_{31}\mathrm{Ga} \xrightarrow{\text{68 min}} {}^{68}_{30}\mathrm{Zn} + 14\ \mathrm{MeV}; $$

$$ {}^{44}_{20}\mathrm{Ca} + {}^{24}_{12}\mathrm{Mg} \rightarrow {}^{68}_{32}\mathrm{Ge} \xrightarrow{\text{271 days}} {}^{68}_{31}\mathrm{Ga} \xrightarrow{\text{68 min}} {}^{68}_{30}\mathrm{Zn} + 14\ \mathrm{MeV}. $$

Chromium

$$ {}^{24}_{12}\mathrm{Mg} + {}^{28}_{14}\mathrm{Si} \rightarrow {}^{52}_{26}\mathrm{Fe} \xrightarrow{\text{8 hours}} {}^{52}_{25}\mathrm{Mn} \xrightarrow{\text{6 days}} {}^{52}_{24}\mathrm{Cr} + 19\ \mathrm{MeV}; $$

$$ 2\,{}^{26}_{12}\mathrm{Mg} \rightarrow {}^{52}_{24}\mathrm{Cr} + 23\ \mathrm{MeV}; $$

$$ {}^{23}_{11}\mathrm{Na} + {}^{29}_{14}\mathrm{Si} \rightarrow {}^{52}_{25}\mathrm{Mn}^* \xrightarrow{\text{6 days}} {}^{52}_{24}\mathrm{Cr} + 23\ \mathrm{MeV}; $$

$$ {}^{23}_{11}\mathrm{Na} + {}^{30}_{14}\mathrm{Si} \rightarrow {}^{53}_{25}\mathrm{Mn}^* \xrightarrow{\text{4 mln years}} {}^{53}_{24}\mathrm{Cr} + 21\ \mathrm{MeV}. $$

Vanadium

$$ {}^{23}_{11}\mathrm{Na} + {}^{28}_{14}\mathrm{Si} \rightarrow {}^{51}_{25}\mathrm{Mn}^* \xrightarrow{\text{46 min}} {}^{51}_{24}\mathrm{Cr}^* \xrightarrow{\text{28 days}} {}^{51}_{23}\mathrm{V} + 20\ \mathrm{MeV}. $$

Scandium

$$ {}^{34}_{16}\mathrm{S} + {}^{11}_{5}\mathrm{B} \rightarrow {}^{45}_{21}\mathrm{Sc} + 20\ \mathrm{MeV}. $$

Gallium

$$ {}^{40}_{20}\mathrm{Ca} + {}^{29}_{14}\mathrm{Si} \rightarrow {}^{69}_{34}\mathrm{Se}^* \xrightarrow{\text{27 s}} {}^{69}_{33}\mathrm{As}^* \xrightarrow{\text{15 min}} {}^{69}_{32}\mathrm{Ge}^* \xrightarrow{\text{39 hours}} {}^{69}_{31}\mathrm{Ga}+11\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{29}_{14}\mathrm{Si} \rightarrow {}^{71}_{34}\mathrm{Se}^* \xrightarrow{\text{5 min}} {}^{71}_{33}\mathrm{As}^* \xrightarrow{\text{65 hours}} {}^{71}_{32}\mathrm{Ge}^* \xrightarrow{\text{11 days}} {}^{71}_{31}\mathrm{Ga} +8\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{69}_{33}\mathrm{As}^* \xrightarrow{\text{15 min}} {}^{69}_{32}\mathrm{Ge}^* \xrightarrow{\text{39 hours}} {}^{69}_{31}\mathrm{Ga} + 13\ \mathrm{MeV}; $$

$$ {}^{44}_{20}\mathrm{Ca} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{71}_{33}\mathrm{As}^* \xrightarrow{\text{65 hours}} {}^{71}_{32}\mathrm{Ge}^* \xrightarrow{\text{11 days}} {}^{71}_{31}\mathrm{Ga} + 10\ \mathrm{MeV}; $$

$$ {}^{41}_{19}\mathrm{K}+{}^{28}_{14}\mathrm{Si} \rightarrow {}^{69}_{33}\mathrm{As}^* \xrightarrow{\text{15 min}} {}^{69}_{32}\mathrm{Ge}^* \xrightarrow{\text{39 hours}} {}^{69}_{31}\mathrm{Ga} + 11\ \mathrm{MeV}. $$

Germanium

$$ {}^{41}_{19}\mathrm{K} + {}^{31}_{15}\mathrm{P} \rightarrow {}^{72}_{34}\mathrm{Se}^* \xrightarrow{\text{8 days}} {}^{72}_{33}\mathrm{As}^* \xrightarrow{\text{26 hours}} {}^{72}_{32}\mathrm{Ge} + 12\ \mathrm{MeV}; $$

$$ {}^{39}_{19}\mathrm{K} + {}^{31}_{15}\mathrm{P} \rightarrow {}^{70}_{34}\mathrm{Se}^* \xrightarrow{\text{41 min}} {}^{70}_{33}\mathrm{As}^* \xrightarrow{\text{53 min}} {}^{70}_{32}\mathrm{Ge} + 11\ \mathrm{MeV}. $$

Bromine

Bromine can be regarded almost as a sea element because the ocean contains 99% of all bromine deposits in the Earth core.[1]

$$ {}^{40}_{20}\mathrm{Ca}+{}^{39}_{19}\mathrm{K} \rightarrow {}^{79}_{39}\mathrm{Y}^* \xrightarrow{\text{15 s}} {}^{79}_{38}\mathrm{Sr}^* \xrightarrow{\text{2 min}} {}^{79}_{37}\mathrm{Rb}^* \xrightarrow{\text{23 min}} {}^{79}_{36}\mathrm{Kr}^* \xrightarrow{\text{35 hours}} {}^{79}_{35}\mathrm{Br} + 5\ \mathrm{MeV}; $$

$$ {}^{40}_{20}\mathrm{Ca}+{}^{41}_{19}\mathrm{K} \rightarrow {}^{81}_{39}\mathrm{Y}^* \xrightarrow{\text{70 s}} {}^{81}_{38}\mathrm{Sr}^* \xrightarrow{\text{22 min}} {}^{81}_{37}\mathrm{Rb}^* \xrightarrow{\text{5 hours}} {}^{81}_{36}\mathrm{Kr}^* \xrightarrow{\text{229000 years}} {}^{81}_{35}\mathrm{Br} + 6\ \mathrm{MeV}. $$

Selenium

$$ {}^{40}_{20}\mathrm{Ca} + {}^{34}_{16}\mathrm{S} \rightarrow {}^{74}_{36}\mathrm{Kr}^* \xrightarrow{\text{12 min}} {}^{74}_{35}\mathrm{Br}^* \xrightarrow{\text{25 min}} {}^{74}_{34}\mathrm{Se} + 6\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{32}_{16}\mathrm{S} \rightarrow {}^{74}_{36}\mathrm{Kr}^* \xrightarrow{\text{12 min}} {}^{74}_{35}\mathrm{Br}^* \xrightarrow{\text{25 min}} {}^{74}_{34}\mathrm{Se} + 7\ \mathrm{MeV}; $$

$$ {}^{40}_{20}\mathrm{Ca} + {}^{36}_{16}\mathrm{S} \rightarrow {}^{76}_{36}\mathrm{Kr}^* \xrightarrow{\text{15 hours}} {}^{76}_{35}\mathrm{Br}^* \xrightarrow{\text{16 hours}} {}^{76}_{34}\mathrm{Se} + 9\ \mathrm{MeV}; $$

$$ {}^{42}_{20}\mathrm{Ca} + {}^{34}_{16}\mathrm{S} \rightarrow {}^{76}_{36}\mathrm{Kr}^* \xrightarrow{\text{15 hours}} {}^{76}_{35}\mathrm{Br}^* \xrightarrow{\text{16 hours}} {}^{76}_{34}\mathrm{Se} + 6\ \mathrm{MeV}; $$

$$ {}^{44}_{20}\mathrm{Ca} + {}^{32}_{16}\mathrm{S} \rightarrow {}^{76}_{36}\mathrm{Kr}^* \xrightarrow{\text{15 hours}} {}^{76}_{35}\mathrm{Br}^* \xrightarrow{\text{16 hours}} {}^{76}_{34}\mathrm{Se} + 7\ \mathrm{MeV}; $$

$$ {}^{43}_{20}\mathrm{Ca} + {}^{34}_{16}\mathrm{S} \rightarrow {}^{77}_{36}\mathrm{Kr}^* \xrightarrow{\text{74 min}} {}^{77}_{35}\mathrm{Br}^* \xrightarrow{\text{57 hours}} {}^{77}_{34}\mathrm{Se} + 5\ \mathrm{MeV}. $$

Selenium can also be formed from titanium yielded in Reactions 5 and 6:

$$ {}^{28}_{14}\mathrm{Si} + {}^{48}_{22}\mathrm{Ti} \rightarrow {}^{76}_{36}\mathrm{Kr}^* \xrightarrow{\text{15 hours}} {}^{76}_{35}\mathrm{Br}^* \xrightarrow{\text{16 hours}} {}^{76}_{34}\mathrm{Se} + 4\ \mathrm{MeV}; $$

$$ {}^{29}_{14}\mathrm{Si} + {}^{48}_{22}\mathrm{Ti} \rightarrow {}^{77}_{36}\mathrm{Kr}^* \xrightarrow{\text{74 min}} {}^{77}_{35}\mathrm{Br}^* \xrightarrow{\text{57 hours}} {}^{77}_{34}\mathrm{Se} + 3\ \mathrm{MeV}; $$

$$ {}^{30}_{14}\mathrm{Si} + {}^{47}_{22}\mathrm{Ti} \rightarrow {}^{77}_{36}\mathrm{Kr}^* \xrightarrow{\text{74 min}} {}^{77}_{35}\mathrm{Br}^* \xrightarrow{\text{57 hours}} {}^{77}_{34}\mathrm{Se} + 4\ \mathrm{MeV}; $$

$$ {}^{30}_{14}\mathrm{Si} + {}^{46}_{22}\mathrm{Ti} \rightarrow {}^{76}_{36}\mathrm{Kr}^* \xrightarrow{\text{15 hours}} {}^{76}_{35}\mathrm{Br}^* \xrightarrow{\text{16 hours}} {}^{76}_{34}\mathrm{Se} + 6\ \mathrm{MeV}. $$

The following reactions take place with the participation of copper, zinc and gallium isotopes formed in previous reactions.

Molybdenum

$$ {}^{65}_{29}\mathrm{Cu} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{92}_{42}\mathrm{Mo} + 2\ \mathrm{MeV}; $$

$$ {}^{68}_{30}\mathrm{Zn} + {}^{24}_{12}\mathrm{Mg} \rightarrow {}^{92}_{42}\mathrm{Mo} + 3\ \mathrm{MeV}; $$

$$ {}^{67}_{30}\mathrm{Zn} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{92}_{42}\mathrm{Mo} + 6\ \mathrm{MeV}; $$

$$ {}^{66}_{30}\mathrm{Zn} + {}^{26}_{12}\mathrm{Mg} \rightarrow {}^{92}_{42}\mathrm{Mo} +2\ \mathrm{MeV}; $$

$$ {}^{71}_{31}\mathrm{Ga} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{96}_{43}\mathrm{Tc}^* \xrightarrow{\text{4 days}} {}^{96}_{42}\mathrm{Mo} + 5\ \mathrm{MeV}; $$

$$ {}^{69}_{31}\mathrm{Ga} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{94}_{43}\mathrm{Tc}^* \xrightarrow{\text{293 min}} {}^{94}_{42}\mathrm{Mo} + 5\ \mathrm{MeV}; $$

$$ {}^{69}_{31}\mathrm{Ga} + {}^{26}_{12}\mathrm{Mg} \rightarrow {}^{95}_{43}\mathrm{Tc}^* \xrightarrow{\text{20 hours}} {}^{95}_{42}\mathrm{Mo} + 2\ \mathrm{MeV}; $$

$$ {}^{69}_{31}\mathrm{Ga} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{94}_{43}\mathrm{Tc}^* \xrightarrow{\text{293 min}} {}^{94}_{42}\mathrm{Mo} + 5\ \mathrm{MeV}; $$

$$ {}^{71}_{31}\mathrm{Ga} + {}^{24}_{12}\mathrm{Mg} \rightarrow {}^{95}_{43}\mathrm{Tc}^* \xrightarrow{\text{20 hours}} {}^{95}_{42}\mathrm{Mo} + 3\ \mathrm{MeV}. $$

Zirconium

$$ {}^{67}_{30}\mathrm{Zn} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{90}_{41}\mathrm{Nb}^* \xrightarrow{\text{15 hours}} {}^{90}_{40}\mathrm{Zr} + 11\ \mathrm{MeV}; $$

$$ {}^{68}_{30}\mathrm{Zn} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{91}_{41}\mathrm{Nb}^* \xrightarrow{\text{680 years}} {}^{91}_{40}\mathrm{Zr} + 8\ \mathrm{MeV}; $$

$$ {}^{63}_{29}\mathrm{Cu} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{90}_{42}\mathrm{Mo}^* \xrightarrow{\text{6 hours}} {}^{90}_{41}\mathrm{Nb}^* \xrightarrow{\text{15 hours}} {}^{90}_{40}\mathrm{Zr} + 5\ \mathrm{MeV}. $$

Strontium

$$ {}^{65}_{29}\mathrm{Cu} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{88}_{40}\mathrm{Zr}^* \xrightarrow{\text{83 days}} {}^{88}_{39}\mathrm{Y}^* \xrightarrow{\text{107 days}} {}^{88}_{38}\mathrm{Sr} + 10\ \mathrm{MeV}; $$

$$ {}^{63}_{29}\mathrm{Cu} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{86}_{40}\mathrm{Zr}^* \xrightarrow{\text{17 hours}} {}^{86}_{39}\mathrm{Y}^* \xrightarrow{\text{15 hours}} {}^{86}_{38}\mathrm{Sr} + 8\ \mathrm{MeV}; $$

$$ {}^{54}_{26}\mathrm{Fe} + {}^{32}_{16}\mathrm{S} \rightarrow {}^{86}_{42}\mathrm{Mo}^* \xrightarrow{\text{20 s}} {}^{86}_{41}\mathrm{Nb}^* \xrightarrow{\text{88 s}} {}^{86}_{40}\mathrm{Zr}^* \xrightarrow{\text{17 hours}} {}^{86}_{39}\mathrm{Y}^* \xrightarrow{\text{15 hours}} {}^{86}_{39}\mathrm{Sr} + 0.2\ \mathrm{MeV}; $$

$$ {}^{55}_{25}\mathrm{Mn} + {}^{33}_{16}\mathrm{S} \rightarrow {}^{88}_{41}\mathrm{Nb}^* \xrightarrow{\text{15min}} {}^{88}_{40}\mathrm{Zr} \xrightarrow{\text{83days}} {}^{88}_{39}\mathrm{Y} \xrightarrow{\text{106days}} {}^{88}_{38}\mathrm{Sr} + 2\ \mathrm{MeV}; $$

$$ {}^{64}_{30}\mathrm{Zn} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{87}_{41}\mathrm{Nb}^* \xrightarrow{\text{4min}} {}^{87}_{40}\mathrm{Zr}^* \xrightarrow{\text{2 hours}} {}^{87}_{39}\mathrm{Y}^* \xrightarrow{\text{80hours}} {}^{87}_{38}\mathrm{Sr} + 8\ \mathrm{MeV}; $$

$$ {}^{41}_{19}\mathrm{K} + {}^{46}_{22}\mathrm{Ti} \rightarrow {}^{87}_{41}\mathrm{Nb}^* \xrightarrow{\text{4min}} {}^{87}_{40}\mathrm{Zr}^* \xrightarrow{\text{2 hours}} {}^{87}_{39}\mathrm{Y}^* \xrightarrow{\text{80hours}} {}^{87}_{38}\mathrm{Sr} + 4\ \mathrm{MeV}. $$

Yttrium

$$ {}^{66}_{30}\mathrm{Zn} + {}^{23}_{11}\mathrm{Na} \rightarrow {}^{89}_{41}\mathrm{Nb}^* \xrightarrow{\text{2 hours}} {}^{89}_{40}\mathrm{Zr}^* \xrightarrow{\text{78 hours}} {}^{89}_{39}\mathrm{Y} + 8\ \mathrm{MeV}. $$

$$ {}^{24}_{12}\mathrm{Mg} + {}^{65}_{29}\mathrm{Cu} \rightarrow {}^{89}_{41}\mathrm{Nb}^* \xrightarrow{\text{2 hours}} {}^{89}_{40}\mathrm{Zr}^* \xrightarrow{\text{78 hours}} {}^{89}_{39}\mathrm{Y} + 5\ \mathrm{MeV}. $$

Niobium

$$ {}^{68}_{30}\mathrm{Zn} + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{93}_{42}\mathrm{Mo}^* \xrightarrow{\text{4000 years}} {}^{93}_{41}\mathrm{Nb} + 3\ \mathrm{MeV}; $$

$$ {}^{67}_{30}\mathrm{Zn} + {}^{26}_{12}\mathrm{Mg} \rightarrow {}^{93}_{42}\mathrm{Mo}^* \xrightarrow{\text{4000 years}} {}^{93}_{41}\mathrm{Nb} + 3\ \mathrm{MeV}. $$

Tin

$$ {}^{95}_{42}\mathrm{Mo} + {}^{17}_{8}\mathrm{O} \rightarrow {}^{112}_{50}\mathrm{Sn} + 0.1\ \mathrm{MeV}; $$

$$ {}^{97}_{42}\mathrm{Mo} + {}^{17}_{8}\mathrm{O} \rightarrow {}^{114}_{50}\mathrm{Sn} + 2\ \mathrm{MeV}; $$

$$ {}^{98}_{42}\mathrm{Mo} + {}^{17}_{8}\mathrm{O} \rightarrow {}^{115}_{50}\mathrm{Sn} + 1\ \mathrm{MeV}; $$

$$ {}^{98}_{42}\mathrm{Mo} + {}^{18}_{8}\mathrm{O} \rightarrow {}^{116}_{50}\mathrm{Sn} + 3\ \mathrm{MeV}. $$

Iodine

$$^{114}_{50}Sn + ^{13}_{6}C \rightarrow ^{127}_{56}Ba^* \xrightarrow{\text{13 min}} ^{127}_{55}Cs^* \xrightarrow{\text{6 hours}} ^{127}_{54}Xe^* \xrightarrow{\text{36 days}} ^{127}_{53}I + 0.015\,MeV;$$

$$^{116}_{50}Sn + ^{11}_{5}B \rightarrow ^{127}_{55}Cs^* \xrightarrow{\text{6 hours}} ^{127}_{54}Xe^* \xrightarrow{\text{36 days}} ^{127}_{53}I + 5\ MeV;$$

$$^{117}_{50}Sn + ^{10}_{5}B \rightarrow ^{127}_{55}Cs^* \xrightarrow{\text{6 hours}} ^{127}_{54}Xe^* \xrightarrow{\text{36 days}} ^{127}_{53}I + 10\ MeV;$$

$$^{118}_{50}Sn + ^{9}_{4}Be \rightarrow ^{127}_{54}Xe^* \xrightarrow{\text{36 days}} ^{127}_{53}I + 8\ MeV;$$

$$^{120}_{50}Sn + ^{7}_{3}Li \rightarrow ^{127}_{53}I + 13\ MeV;$$

$$^{121}_{51}Sb + ^{6}_{3}Li \rightarrow ^{127}_{54}Xe^* \xrightarrow{\text{36 days}} ^{127}_{53}I + 13\ MeV.$$

The lack of iodine in nodules is explained by the fact that most inorganic compounds of this element are easily soluble in water, therefore they pass into it at the time of their formation.

Tungsten

Sea water contains ytterbium,[2] which under its interaction with lithium isotopes as a result of the beta-decay of tantalum isotopes yields tungsten.

$$^{173}_{70}Yb + ^{7}_{3}Li \rightarrow ^{180}_{73}Ta^* - ^{0}_{-1}e \xrightarrow{\text{8 hours}} ^{180}_{74}W + 7\ MeV$$

$$^{174}_{70}Yb + ^{6}_{3}Li \rightarrow ^{180}_{73}Ta^* - ^{0}_{-1}e \xrightarrow{\text{8 hours}} ^{180}_{74}W + 7\ MeV$$

$$^{176}_{70}Yb + ^{6}_{3}Li \rightarrow ^{182}_{73}Ta^* - ^{0}_{-1}e \xrightarrow{\text{114 days}} ^{182}_{74}W + 9\ MeV$$

Hafnium

$$^{170}_{70}Yb + ^{6}_{3}Li \rightarrow ^{176}_{73}Ta^* \xrightarrow{\text{7 min}} ^{176}_{72}Hf + 7\ MeV;$$

$$^{171}_{70}Yb + ^{6}_{3}Li \rightarrow ^{177}_{73}Ta^* \xrightarrow{\text{57 hours}} ^{177}_{72}Hf + 7\ MeV;$$

$$^{172}_{69}Yb + ^{6}_{3}Li \rightarrow ^{178}_{72}Hf + 7\ MeV.$$

Rhenium

Rhenium arises from the LENR-interaction of lithium and hafnium.

$$^{178}_{72}Hf + ^{7}_{3}Li \rightarrow ^{185}_{75}Re + 6\ MeV;$$

$$^{179}_{72}Hf + ^{6}_{3}Li \rightarrow ^{185}_{75}Re + 7\ MeV.$$

Silver

$$^{93}_{41}Nb + ^{14}_{7}N \rightarrow ^{107}_{48}Cd^* \xrightarrow{\text{6 hours}} ^{107}_{47}Ag + 3\ MeV;$$

$$^{97}_{42}Mo + ^{10}_{5}B \rightarrow ^{107}_{47}Ag + 13\ MeV;$$

$$^{98}_{42}Mo + ^{11}_{5}B \rightarrow ^{109}_{47}Ag + 9\ MeV.$$

Cadmium

$$^{98}_{42}Mo + ^{14}_{7}N \rightarrow ^{112}_{49}In^* \xrightarrow{\text{15min}} ^{112}_{48}Cd + 5\ MeV;$$

$$^{97}_{42}Mo + ^{15}_{7}N \rightarrow ^{112}_{49}In^* \xrightarrow{\text{15min}} ^{112}_{48}Cd + 4\ MeV;$$

$$^{98}_{42}Mo + ^{10}_{5}B \rightarrow ^{108}_{47}Ag^* - ^{0}_{-1}e \xrightarrow{\text{2 min}} ^{108}_{48}Cd + 14\ MeV;$$

$$^{97}_{42}Mo + ^{11}_{5}B \rightarrow ^{108}_{47}Ag^* - ^{0}_{-1}e \xrightarrow{\text{2 min}} ^{108}_{48}Cd + 11\ MeV.$$

In the last two cases $^{108}_{47}Ag^*$ decay occurs by means of beta radiation.

Indium

$$^{98}_{42}Mo + ^{15}_{7}N \rightarrow ^{113}_{49}In + 1\ MeV;$$

$$^{96}_{40}Zr + ^{19}_{9}F \rightarrow ^{115}_{49}In + 3\ MeV.$$

Palladium

$$^{92}_{42}Mo + ^{10}_{5}B \rightarrow ^{102}_{47}Ag^* \xrightarrow{\text{13 min}} ^{102}_{46}Pd + 13\ MeV;$$

$$^{94}_{42}Mo + ^{10}_{5}B \rightarrow ^{104}_{47}Ag^* \xrightarrow{\text{69 min}} ^{104}_{46}Pd + 13\ MeV;$$

$$^{94}_{42}Mo + ^{11}_{5}B \rightarrow ^{105}_{47}Ag^* \xrightarrow{\text{41 days}} ^{105}_{46}Pd + 8\ MeV;$$

$$^{95}_{42}Mo + ^{11}_{5}B \rightarrow ^{106}_{47}Ag^* \xrightarrow{\text{24 min}} ^{106}_{46}Pd + 10\ MeV;$$

$$^{95}_{42}Mo + ^{10}_{5}B \rightarrow ^{105}_{47}Ag^* \xrightarrow{\text{41 days}} ^{105}_{46}Pd + 12\ MeV;$$

$$^{96}_{42}Mo + ^{10}_{5}B \rightarrow ^{106}_{47}Ag^* \xrightarrow{\text{24 min}} ^{106}_{46}Pd + 13\ MeV.$$

Rhodium

$$^{89}_{39}Y + ^{14}_{7}N \rightarrow ^{103}_{46}Pd^* \xrightarrow{\text{17 days}} ^{103}_{45}Rh + 3\ MeV;$$

$$^{92}_{42}Mo + ^{11}_{5}B \rightarrow ^{103}_{47}Ag^* \xrightarrow{\text{66 min}} ^{103}_{46}Pd^* \xrightarrow{\text{17 days}} ^{103}_{45}Rh + 9\ MeV.$$

Antimony

$$^{108}_{48}Cd + ^{13}_{6}C \rightarrow ^{121}_{54}Xe^* + ^{0}_{-1}e \xrightarrow{\text{40 min}} ^{121}_{53}I^* \xrightarrow{\text{2 hours}} ^{121}_{52}Te^* \xrightarrow{\text{19 days}} ^{121}_{51}Sb + 2\ MeV;$$

$$^{9}_{4}Be + ^{112}_{48}Cd \rightarrow ^{121}_{52}Te^* \xrightarrow{\text{16 days}} ^{121}_{51}Sb + 10\ MeV.$$

Tellurium

$$^{112}_{48}Cd + ^{10}_{5}B \rightarrow ^{122}_{53}I^* \xrightarrow{\text{4 min}} ^{122}_{52}Te + 11\ MeV;$$

$$^{115}_{49}In + ^{10}_{5}B \rightarrow ^{125}_{54}Xe^* \xrightarrow{\text{17 hours}} ^{125}_{53}I^* \xrightarrow{\text{59 days}} ^{125}_{52}Te + 11\ MeV;$$

$$^{114}_{48}Cd + ^{11}_{5}B \rightarrow ^{125}_{53}I^* \xrightarrow{\text{59 days}} ^{125}_{52}Te + 7\ MeV.$$

Barium

$$^{122}_{52}Te + ^{10}_{5}B \rightarrow ^{132}_{57}La^* \xrightarrow{\text{5 hours}} ^{132}_{56}Ba + 10\ MeV;$$

$$^{125}_{52}Te + ^{10}_{5}B \rightarrow ^{135}_{57}La^* \xrightarrow{\text{20 hours}} ^{135}_{56}Ba + 10\ MeV.$$

Neodymium

$$^{133}_{55}Cs + ^{10}_{5}B \rightarrow ^{143}_{60}Nd + 8\ MeV;$$

$$^{132}_{56}Ba + ^{10}_{5}B \rightarrow ^{142}_{61}Pm^* \xrightarrow{\text{41 s}} ^{142}_{60}Nd + 9\ MeV;$$

$$^{132}_{56}Ba + ^{11}_{5}B \rightarrow ^{143}_{61}Pm^* \xrightarrow{\text{265 days}} ^{143}_{60}Nd + 4\ MeV;$$

$$^{134}_{56}Ba + ^{11}_{5}B \rightarrow ^{145}_{61}Pm^* \xrightarrow{\text{18 years}} ^{145}_{60}Nd + 0.6\ MeV;$$

$$^{135}_{56}Ba + ^{10}_{5}B \rightarrow ^{145}_{61}Pm^* \xrightarrow{\text{18 years}} ^{145}_{60}Nd + 5\ MeV;$$

$$^{135}_{56}Ba + ^{11}_{5}B \rightarrow ^{146}_{61}Pm^* \xrightarrow{\text{6 years}} ^{146}_{60}Nd + 1\ MeV;$$

$$^{136}_{56}Ba + ^{10}_{5}B \rightarrow ^{146}_{61}Pm^* \xrightarrow{\text{6 years}} ^{146}_{60}Nd + 4\ MeV;$$

$$^{138}_{56}Ba + ^{6}_{3}Li \rightarrow ^{144}_{59}Pr^* \xrightarrow{\text{17 min}} ^{144}_{60}Nd + 10\ MeV;$$

$$^{138}_{56}Ba + ^{7}_{3}Li \rightarrow ^{145}_{59}Pr^* \xrightarrow{\text{6 hours}} ^{145}_{60}Nd + 9\ MeV.$$

Lanthanum

$$^{133}_{55}Cs + ^{6}_{3}Li \rightarrow ^{139}_{58}Ce^* \xrightarrow{\text{138 days}} ^{139}_{57}La + 13\ MeV.$$

Cerium

$$^{133}_{55}Cs + ^{7}_{3}Li \rightarrow ^{140}_{57}La^* \xrightarrow{\text{2 days}} ^{140}_{58}Ce + 15\ MeV.$$

Samarium

$$^{137}_{56}Ba + ^{10}_{5}B \rightarrow ^{147}_{61}Pm^* - ^{0}_{-1}e \xrightarrow{\text{3 years}} ^{147}_{62}Sm + 3\ MeV;$$

$$^{137}_{56}Ba + ^{11}_{5}B \rightarrow ^{148}_{61}Pm^* - ^{0}_{-1}e \xrightarrow{\text{5 days}} ^{148}_{62}Sm + 0.8\ MeV;$$

$$^{138}_{56}Ba + ^{10}_{5}B \rightarrow ^{148}_{61}Pm^* - ^{0}_{-1}e \xrightarrow{\text{5 days}} ^{148}_{62}Sm + 4\ MeV.$$

Promethium decay occurs by means of beta radiation.

Thus, at the input of the "blackbox" there are isotopes of light elements Na, Cl, K, Ca, Mg, Si, Al, P, S, Li, B and F. At the output stable isotopes appear: Mn, Fe, Ti, Co, Ni, Zn, Cu, Cr, V, Sc, Ga, Ge, Se, Br, Mo, Zr, Sr, Y, Nb, Sn, W, Hf, Re, Ag, Pd, Rh, In, Cd, Sb, Te, Ba, La, Ce, Nd, Sm, which are really included in nodules.[2,12] Undoubtedly, this list is not exhaustive. Energy balance of all above-mentioned reactions is positive. The actual conditions in which the reactions occur, of course, are their own, so that possibly not all of them happen in reality; however, the presence of a great number of predicted elements in nodules speaks for itself.

Hereby, in the present research LENR-hypothesis is the effective working instrument which enables us to naturally explain the appearance of stable isotopes of many elements really contained in nodules. These findings strongly support the deduction that formation of listed elements highly likely happens at active participation of bacteria as a result of heat-generating LENR mainly by electron capture from inner atomic layers without additional external expenditure of energy, any radioactive materials and hard radiation. Too much weight ought not, however, be given to the role of bacteria since the listed elements (for example, manganese) can be formed not only at their participation (in nodules) but without it (in fulgurites); this clearly points to the action of common LENR-mechanism. Undoubtedly, the further detailed investigation of this mechanism (inner structure of the "blackbox") will open up new startling discoveries, inventions and exciting vistas of their technical usage.

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About the Author
Boris Andrianov was an Associate Professor of General and Experimental Physics at South Ural State University (National Research University) in Chelyabinsk, Russia.

*Email: borisandr47@gmail.com

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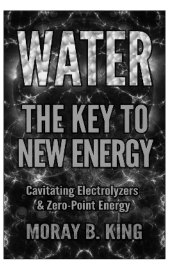

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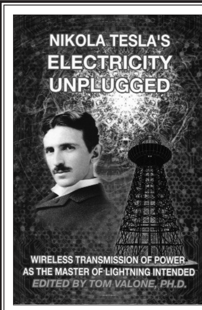

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