30 years of history

zeo Mineral products

Zeomineral Products

A mineralogical and genetic overview and beneficial qualities of Tokaj-Hegyalja zeolites of natural medicinal qualities

Introductory thoughts

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Against your aches, pain and fever, nature‘s remedies have the answer?

What is the scientific ground for these words of wisdom?

According to our present knowledge, among the 87 known natural elements, 29 had a decisive role in the emergence of life:

PRIMARY BIO-ELEMENTS	H, O, C, N, S, P
SECONDARY BIO-ELEMENTS	Fe, Mg, Ca, Na, K
BIO-TRACE ELEMENTS	Li, B, I, Cl, Br, Al, Si, Ti, Cr, Mn, Co, Cu, Zn, Se, Mo, Bi, V, Rb

The elements of all three groups were piled up and evenly spread in the area 10-12 million years ago by the volcanicity of the Tokaj Mountains. By means of volcanic and post volcanic processes in the past, those chemical materials that provided a natural environment and a cradle for the life on earth were brought to the surface by the volcanic melt escaping the depths (30-35 km) of the earth’s crust.

Today’s modern, production-centred agriculture has unthinkingly reduced the trace elements, which should be present in the upper ground level, by restraining the supply of natural farmyard manure and over-fertilizing. Thus, the above mentioned trace elements are not transferred from the earth to plants, from plants to animals, from animals to human beings standing at the top of the food chain.

The lack or insufficiency of bio-trace elements does not put an end to life as we know it; however, it contributes to serious functional disorders (e.g. the lack of iodine causes goitre).

A whole range of fashionable lifestyle diseases has appeared (nervousness, indigestion, circulatory troubles, rheumatic complaints, and a general deterioration of the immune system).

To fight off illnesses, humankind has started using chemicals declared to be modern. Should these pharmaceuticals have positive effect on given disorders, their side effects may make more harm than the disorder itself.

Established in 1984, our company, having been doing research since the beginning of the 1970’s, has determined to supply living organisms with natural materials that have no side effects but ensure detoxification, the stability of the immune system and the ingestion of important trace elements. These elements can be found in the earth’s crust, rocks and minerals.

Enteral powders, tooth-powders, talcum powders, mineral-dermatological pastes, special bath-salts help to fend off digestive, gynaecological, dental and dermatologic complaints. Beside direct application, the curative effects of minerals can also be indirectly employed. Mineral treatments of the soil, plant protection by sprinkling, foraging livestock with objective oriented mineral products may also contribute to the well-being of people at the top of the food chain by fending off lifestyle diseases.

A general introduction to mineral resource and mining

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The parts of the earth’s crust which can be made use by human society are called mineral resources. This definition includes the dynamic historical broadening of the numbers of mineral resources.

Mining is an industrial sector producing true value. The level of human development can be defined by the raw materials’ stages of procession that come out of this industrial sector. Real value is produced by the mining sector directly after extraction or by providing other downstream industries with raw material. Metallurgy, mechanical engineering, building industry and computer science are unimaginable to go on without this activity (e.g. a residential building consists of 95-96% of mining products).

This industry satisfies a social need that is the ground for the survival of the human race and its sustainable development. The accelerating need for the raw materials of the earth’s crust is illustrated in the following chart.

The people of prehistoric times knew 13 different mineral resources. The number of these resources increased to 20 at the time of the Egyptian and Mesopotamian cultures while this number increased to 26 during the Hellenic culture and in Roman times they already knew of more than 30 minerals. The principal eras of human history are not determined by the ’isms’ of sociology but by the gradual exploitation of the materials of the earth’s crust: Copper Age, Bronze Age, Iron Age, and the age of alloying metals, light metals, rare metals, and rare elements. These ages succeeded one another, from the first stone-axe to the space shuttle.

Nowadays, if we take the lithological variations into consideration, the number of crust minerals used by humanity exceeds five hundred. In spite of this fact, further minerals are raised to the rank of raw materials in demand by technical improvement. In the 1950’s, the mining of the ocean floor for minerals began, after the turn of the millennium, one must reckon with the exploitation of the mineral substances of the earth’s mantle.

YEARS BEFORE	GEOLOGICAL ERA, STAGE		CLIMATE cold, dry	CLIMATE warm, humid	ERAS OF HUMAN CULTURE	TYPE OF PREHISTORIC MAN	BRAIN SIZE	CULTURES TRACED BY TOOLS	CRUST MATERIALS USED
3180	Holocene	Oak			Late Stone Age	Iron Age	1,350	3180 – using iron in the Greek Islands	Telluric iron, magnetite
4000		Hazel				Bronze Age		3540 – Egyptian New Empire 3800 – Egyptian and European Bronze Age	monolithic architecture: granite Glass making: silicates, tin, gold, silver
7000		Birch				Copper Age		4000 – Sumerian culture 5700 – Ubaidian culture (Mesop.) Tell-Halaf (Mesopotamia)	asphalt, gold, silver, copper smithy, cold-hammered mineral copper
12 000		Pine			Middle Stone A. Copper Age	Dry belt of the Old World- Homo sapiens sapiens (modern human species)	1,800	Catal-Hüyük (Anatolia) 9000 – Er-Riha Fortress (Jericho) 10630 – West Persia	hematite, ochre, obsidian, malachtite, turquoise, brick-clay, potter's clay, building stone
120 000	Pleistocene	Worm			Late Stone Age	Cro-Magnon	1,600	20000 Magdalenian cultue 28000 Gravettian culture 30000 Solutrean culture 60000 Aurignacian culture	Venus of Willendorf – limestone cave paintings – bole Coloured silica derivatives
180000		R-W				Homo neanderthaliensis	1,700	Mousterian culture	Flint, obsidian, quartz
300 000		Riss				Homo sapiens (wise man)			
430 000		M-R				Homo erectus (upright man)	1,300	Acheulean culture (France)	Fine flint
480 000		Mindel				Homo habilis (able man)		Olduwan culture	
540 000		G-M				Vertesszolos man Palenthropus heidelbergensis			
600 000		Gtinz				Palenthropus njarasensis Sinathropus pekinensis Pithecantropus erectus			Pre-made flint as tool
1.5-2 M. 10-12 million	Plio-cene					Giganthopithecus Australopithecus habilis Australopithecus robostus		Peble tools	Pebbles, stones as tools carried along, indiscriminately picked
26 million	Miocene					Australopithecus africanus Dryopithecus Pliopithecus	350		Pebbles, stones picked up on the spot

Figure No. 1 The accelerating need for the minerals of the earth's crust throughout humanity's development into society

In these days, the range of radioactive materials (U, Th minerals) and rare elements (Gd, Eu) and especially the range of mineral raw materials are expanding spectacularly. In spite of its relatively small territory, our country has played a special role in this process. Following bentonite in the 1940's, perlite in the late 1950's and the scientific investigation along with our initiative for the utilization of zeolite, since the second half of the 1970's, Hungary has been propelled to the forefront of Europe and the world.

Zeolithic rhyolite tuff as a product of volcanic processes

Rhyolite tuff, as the uppermost positioned volcanic product of the earth's crust became an important, exploitable mineral raw material in the golden age of the Roman Empire. Its way to becoming a raw material and the road to utilization had been rough. The Roman mixed the volcanic ash of Vesuvius, accumulated at Pozzuoli, with caustic lime to make mortar for buildings, roads and walls. This was the first known usage of still not rhyolitic but volcanic tuff.

Zeolite as a mineral was discovered in a copper mine in Lappland, in 1756 by a Swedish mineralogist, Axel Fredrich Cronstedt (1722 – 1765). It was him who named it zeolite in the Greek manner of compounds (Zein = boil, lithos = stone) because of its curiously shaped crystals and fizzing while being boiled. This name has survived and its meaning has been widely extended – Nowadays we know of more than 40 different zeolite minerals. They are categorized accor ing to the appearance of their crystals' shape: 'fibrous', 'crystalline' and 'leafy'.

The more solid variations of rhyolite tuff, as a solid crust material of given composition shaped from volcanic ash and used as a building material, have accompanied the more prominent stages of the European economy's historical development. The loose variations of rhyolite tuff have been used as sand in the southern and central European regions of the Eurasian Mountains by the local population.

Their spreading is linked to types of the pacific and Mediterranean magma provinces of volcanism. As a consequence of the Earth's expansion, there are active volcanoes in the Southern European, Mediterranean regions of Europe. Among these active volcanoes, only Stromboli and Santorini in the Greek I lands are producing recent rhyolite tuff. The ash of Mount Vesuvius and Etna does not contain rhyolite tuff. In the Carpathian Basin, the Inner Carpathian

Volcanic Chain is accompanied by rhyolite tuff masses. In the Hungarian regions of this volcanic chain (Dunazug Mountains, Börzsöny, Cserhát, Mátra, the skirts of Bükk, Tokaj Mountains) – the farther we travel towards the east, the more acidic vulcanite is, so the largest rhyolite tuff masses are found in Tokaj Mountains.

The volcanic melt, which forms in the primary magma chamber, rises to the surface by the explosion of the magma chamber's upper part, and then comes the heavier melt, deposited in the lower parts of the magma chambers. It is easy to comprehend that the character of the process depends on the thickness of the earth's crust. In ocean territories such differentiation can hardly take place in the crust, which is is 4-5 km thick.

In Mediterranean regions, where the crust is 12-20 km thick, there is more chance to it and on the border of continents, where the crust is 30-50 km thick, the differentiation is even more probable, the melt gets more acidic, and it gasifies. Rhyolite tuff appears here as a characteristic kind of rock accompanying the first acidic eruptions. The elements of the entire vertical cross-section of the earth's crust, mobilized into the volcanic funnel, are brought to the surface. These elements are of crucial importance concerning living substance.

Nowadays, we talk about the age of rare trace elements. These elements define the standards of power supply and military engineering. Humankind has also realized that alongside military engineering, trace elements play a crucial role in the operating mechanisms of plants, animals and human beings – different forms of living substance. A new notion has been born: **bio-trace elements.**

These elements belong to the class of light elements. 3-3.5 billions of years ago, when the first appearance of living substance occurred on the surface of the earth, these were the elements that made up the environment, determining the possibilities for the beginnings of life. At present, we believe that these elements are essential for the preservation and regular functioning of present life-forms. Their absence causes functional disorders and other diseases. Nowadays, in an era of trace elements, - besides strategic heavy metals - rhyolite tuff, containing both light trace and rare-trace elements, is becoming a raw material of vital importance in the survival and functioning of living organisms. This fact has elevated rhyolite tuff to a rank of a mineral raw material.

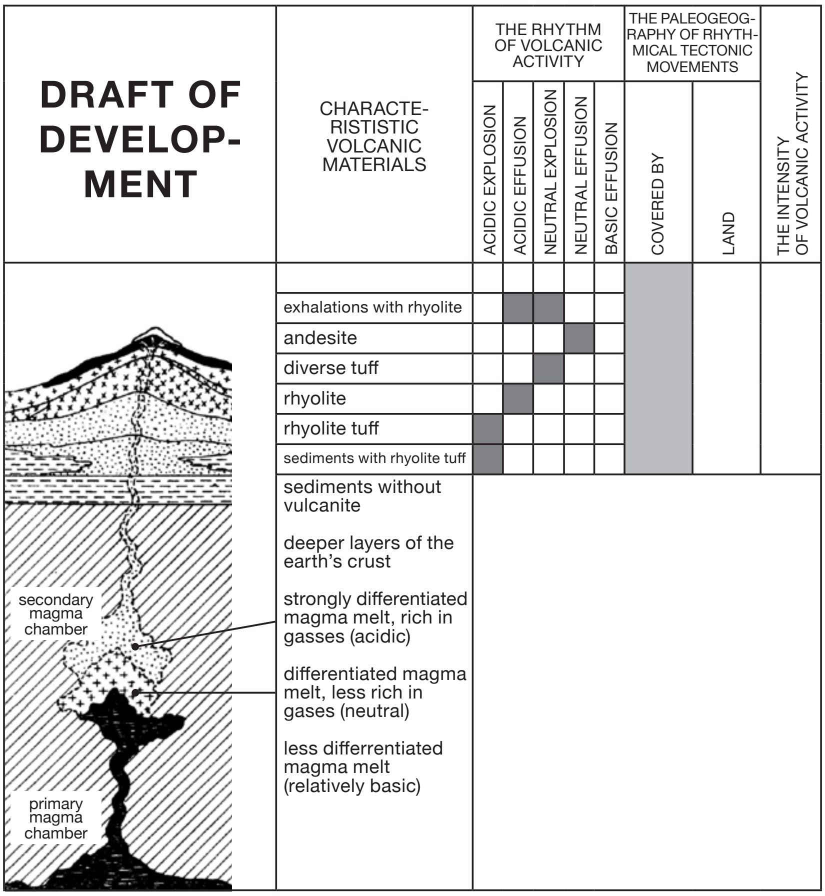

Figure No. 2 A conceptual outline of the Mád region volcanic complex's formation

A brief historical survey of zeolithic rhyolite tuff's biological significance

The recognition of zeolithic rhyolite tuff, in accordance with the development of methods for substance tests and tools, is connected to the 1960s and 1970s, not only in Hungary but all around the world. Hungary, as one of the places where rhyolite tuff can be found on the surface or near the surface, has come to the limelight of European development. The largest rhyolite tuff masses can be found on the slopes of the Tokaj Mountains. One can find both loose and cemented varieties. Local people have used these light, carvable rocks as building material. The biological value of the rocks was brought up by the traditional Tokaj Mountains grape culti-

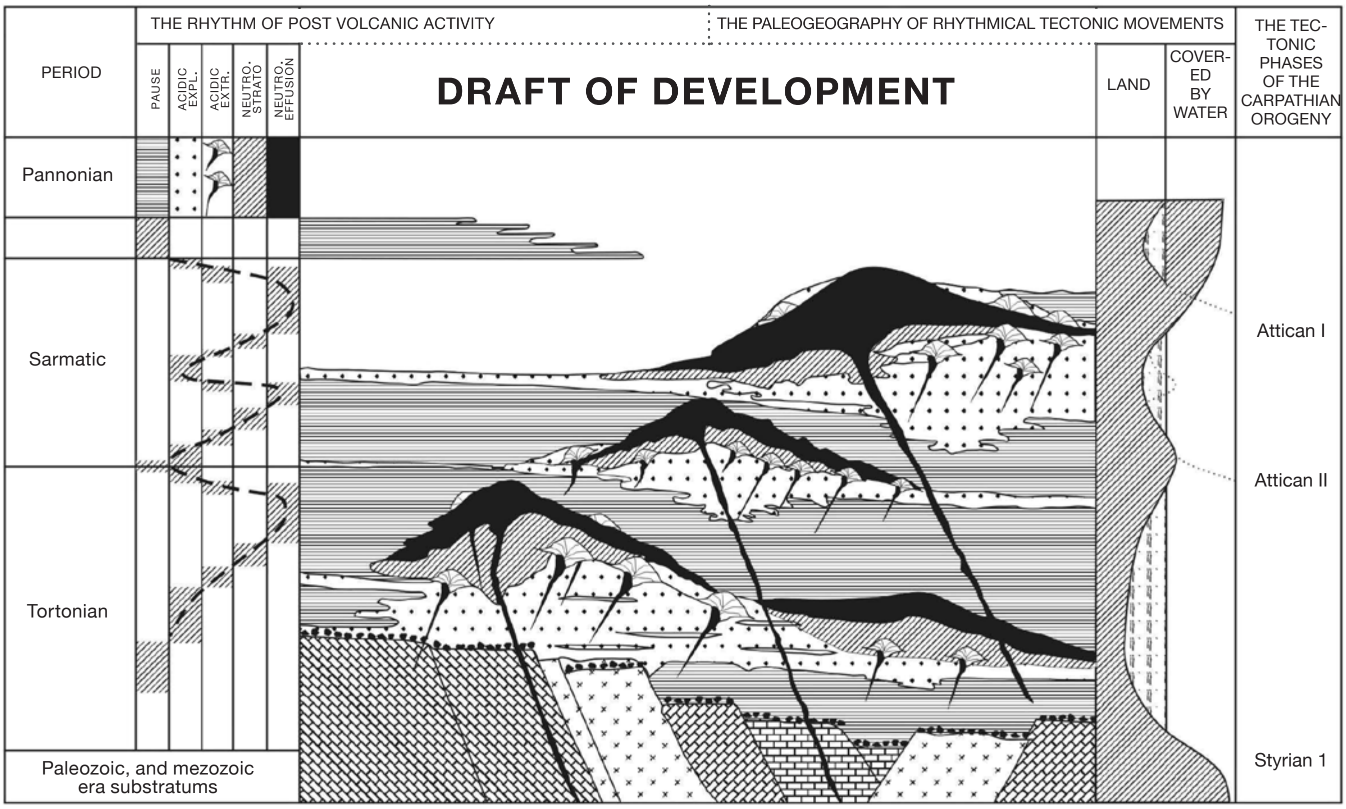

Figure No. 3 A conceptual outline of the layering of Tokaj Mountains‘ neogene vulcanite

vation and the comparison of the rhyolite tuff's places of occurrence. In Tokaj-Hegyalja, vine stalks are 6 m high and the roots of this peculiar plant penetrate the soil 5-6 m deep. On the slopes of the mountains, the roots directly spread in the system of pores and cracks of rhyolite tuff masses. Recognizing regional overlaps and the analysis of the soil in the 1970s unravelled that the flavour and bouquet of wines in the Tokaj-Hegyalja region are linked with the trace elements in rhyolite tuff. Only an inquiry into the interaction of root-hairs and rock particles was needed for the Hungarian researchers to recognize the biological significance of rhyolite tuff. In 1978, 1979, 1980 and 1982, an unprecedented and expansive collaboration was formed among the various research sites of The National Ore and Mineral Mines and The Hungarian Academy of Sciences and the experimental agricultural production units. It came to light, that the presence of rare trace elements is not sufficient in itself but a catalyst is needed to transmit them towards the root-hairs. This type of mineral is contained by rhyolite tuff in the form of zeolites and various ion exchanging clay minerals. So was rhyolite tuff raised to the rank of a raw material, just as our country also rose into the limelight of European and international economic interest by the recognition of the rich zeolite content in certain variants of rhyolite tuff.

By means of its ion exchange capacity, high content of trace and rare trace elements, absorptive capacity, the rhyolite tuff of high zeolite content from the Tokaj Mountains deservedly received a new, specific raw material label: natural **ZEOLITE.**

The genetic composition of zeolites

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Neither the Mediterranean nor the Pacific acidic volcanic activities generate zeolite in itself. Without exceptions, zeolite formation is caused by epigenetic influences. Considering the chemical composition of zeolites, apart from the typically lithospheric elements which make up rocks, the substance of the hydrosphere, aka water plays a role in the process. Their formation and range of stability is set into a zone of low pressure and temperature, which means the well-watered spherical material system of the Earth. The frame, formed by the stable groups (Al, SiO_4) and made from the constituting elements in a condition of lower pressure and temperature (t: 300°C, p: 200), is loose and its required space is large. Trials have proved that by raising pressure and temperature the zeolite structure simply disrupts.

THE PRINCIPLES OF ZEOLITE FORMATION IN THE LIGHT OF STRUCTURE AND MATERIAL QUALITY:

- the energy ensuring the decomposition of aluminium silicates and the formation of the zeolite structure
- water
- time
- relatively low pressure and temperature

The formation of zeolite can only happen if all the conditions are met at the same time. Practically, not only one condition, but an interaction of conditions brings about the formation of zeolite minerals. In terms of mineral composition, zeolithic rhyolite tuffs carry the rockforming elements of the primary volcanic material supply without exception. In addition, as a result of diagenetic changes, strictly under the previously described optimal conditions, zeolite and clay minerals appear in different quantities according to the extent of decomposition and crumbling.

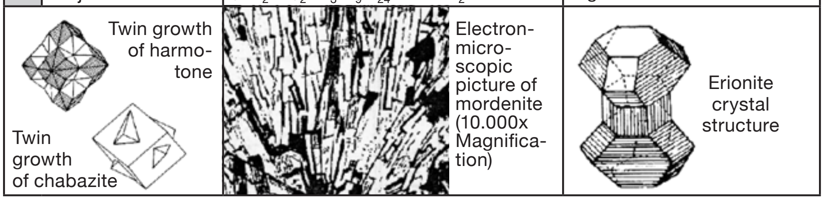
BASED ON SAMPLES, THE MAIN CONSTITUENTS ARE THE FOLLOWING:

1. pumice glass
2. zeolite minerals (clinoptilolite, mordenite)
3. clay minerals (montmorilonite, mixed-layer clay minerals)
4. quartz, feldspar
5. haematite, limonite

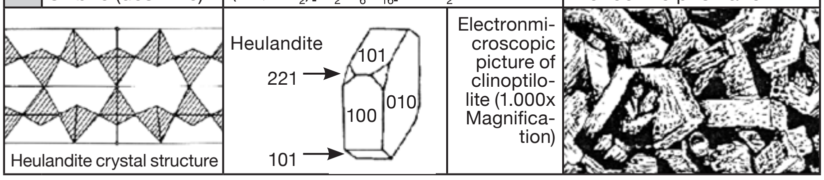
The characteristics of the process and the connection of the formation between individual parts of mineral constitution are indicated by the fact that while the quantity of 3-layered clay minerals increases, the quantity of volcanic glass and intact feldspar decreases at the same time. Both zeolites and clay minerals can be attributed to the decomposition of the glass and feldspar components of acidic pyroclastics. Zeolites with a specific frame occupy an intermediate position among the devitrified, amorphous volcanic glass with high silicic acid content and the 3-layered clay mineral structures. Generally speaking, the decomposition and transformation are accompanied by the following hierarchic phase transformation:

- intact glass (or feldspar)
- devitrified glass (corroded feldspar)
- zeolites
- 3-layered clay minerals

	NAME	CHEMICAL FORMULA	CRYSTAL CLASSIFICATION
CRYSTALLINE ZEOLITES	analcime	$NaAlSi_2O_6 \bullet H_2O$	regular
	chabazite	$(Ca, Na_2)Al_2Si_4O_{12} \bullet 6\,H_2O$	ditrigonal scalenohedral
	gmelinite	$(Ca, Na_2)Al_2Si_4O_{12} \bullet 6\,H_2O$	dihexagonal dipyramidal
	harmotome	$(Ca, K_2)Al_2Si_5O_{14} \bullet 5\,H_2O$	monoclinic prismatic
	levyne	$CaAl_2Si_3O_{10} \bullet H_2O$	rhombohedral
	mordenite	$(Ca, Na_2, K_2)Al_2Si_{10}O_{24} \bullet 6{,}7\,H_2O$	orthorhombic pyramidal
	erionite	$(Na_2, K_2, Ca, Mg)\ 4{,}5\ [Al_9Si_{27}O_{12}] \bullet 27\,H_2O$	dihexagonal pyramidal
	faujasite	$(Na_2Ca)_2[Al_3Si_9O_{24}] \bullet 16\,H_2O$	regular hexakis octahedron



	NAME	CHEMICAL FORMULA	CRYSTAL CLASSIFICATION
LEAFY ZEOLITES	epistilbite (epidesmine)	$CaAl_2Si_6O_{16} \bullet 5\,H_2O$	monoclinic prismatic
	heulandite	$CaAl_2Si_6O_{16} \bullet 5\,H_2O$	monoclinic prismatic
	clinoptilolite	$(Ca, Na_2)[Al_2Si_7O_{18}] \bullet 6H_2O$	monoclinic prismatic
	stilbite (desmine)	$(Ca, Na_2)[Al_2Si_6O_{16}] \bullet 6H_2O$	monoclinic prismatic



	NAME	CHEMICAL FORMULA	CRYSTAL CLASSIFICATION
FIBROUS ZEOLITES	natrolite	$Na_2Al_2Si_8O_{10}] \bullet 2H_2O$	orthorhombic pyramidal
	scolezite	$CaAl_2Si_3O_{10}] \bullet 3H_2O$	monoclinic domatic
	mesolite	$Na_2Ca_2Al_6Si_9O_{30}] \bullet 8H_2O$	monoclinic false orthorhombic
	thomsonite	$(CaNa_2)Al_2Si_2O_8] \bullet 2{,}5\,H_2O$	orthorhombic dipyramidal
	gonnardite	$CaNa_2[(Al, Si)_{10}O_{20}]] \bullet 6\,H_2O$	orthorhombic dipyramidal
	edingtonite	$BaAl_2Si_3O_{10}] \bullet 3\,H_2O$	orthorhombic dipyramidal

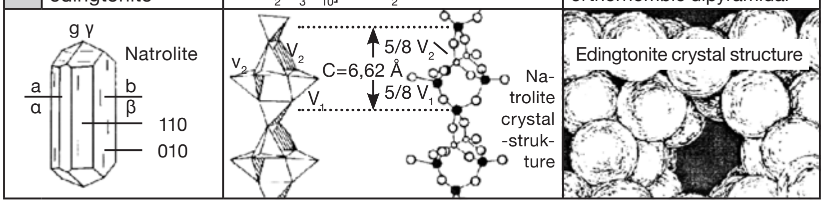
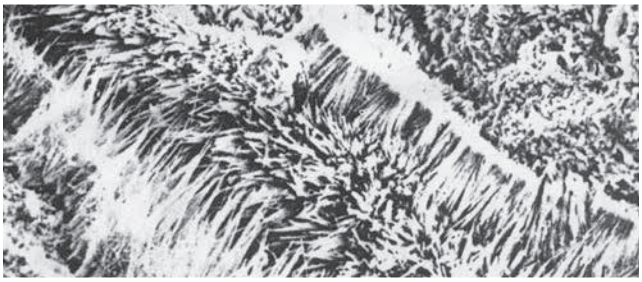
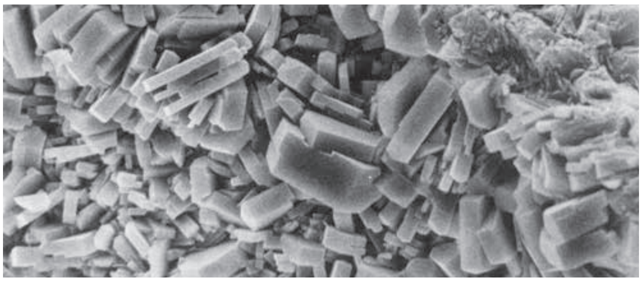


Figure No. 4 Natural zeolites as new mineral raw materials



Fibreglass-like crystal growth of mordenite
– Bodrogkeresztúr occurence



Clinoptilolite crystals from the Mád-Subaoldal zeolite occurence

The place of living substance and human beings in the material system of the earth, bio-elements

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Human beings as biological beings came into existence and organized into a society in a specific zone of the earth's material system, called biosphere. This biosphere was formed on the edge surface of the outer and inner geospheres, in the earth's material system, namely in the contact zone of the atmosphere, hydrosphere and the lithosphere as the result of the interaction of these three zones. Reckoned from the first trace of life, the terrestrial history of living material is approximately 3 billion years old. The most virulent period encompasses circa 600 million years. The conditions for the formation and multiplication of living matter were created in the contact zone of the primeval atmosphere, the primordial ocean and the first fragments of the earth's crust in primeval zones of surf. When living matter came into existence, inevitably, those elements played a role in the processes that were present in the system charged with complex and dynamic interactions. In contrast to the present composition of 78% N_2 and 21% O_2 in the atmosphere, in the primordial atmosphere methane, ammonia, formalin, carbon monoxide and sulphurous gases were the most common. The water of the primordial oceans was contaminated with clay minerals, zeolites, colloid-sized fine particles in addition to brine.

The material of primordial land masses consisted of dark, more basic rocks, rich in magnesium, iron and manganese. In the surf zone, under entirely different conditions of pressure and temperature compared to the present, the first forms of living matter took shape, which were similar organisms to the coccus bacteria of present, according to the finds of Greenland (3.8 billion years) and Swaziland (3.2 billion years).

The creation of living matter happened with the participation of carbon, nitrogen, phosphorus, and sulphur from the atmosphere and also with the two components of H_2O, hydrogen and oxygen. These are the elements that still constitute any form of living matter (plants, animals, human beings); they make up the group of bio-elements. Without them there was not and there is no life. They take part in the construction and processes of living matter in more than 1 per cent. Among the elements of the earth's lithosphere, iron, magnesium, sodium, calcium and potassium play a role in the functioning of living material, especially of the various forms of the higher order of living material. These elements are still so significant that their complete absence causes the termination of vital processes and their diminution endangers the regular functioning of organisms. Their percentage among the elements of living organisms is significantly smaller by being 0.1, 0.01 or even 0.001 per cent.

In addition to the so called secondary bio-elements, a further 18 elements take part in the functions of living matter's, mainly the higher order of living organisms', vital processes. Their required concentration is significantly smaller; it is often only a few tenths of mg/kg. Their absence does not cause such a drastic catastrophe for living organisms as the lack of primary or secondary bio-elements. However, their complete absence or diminished active amount cause functional disorders in living organisms. In case these elements are not supplied for the human body through nutrition, their absence causes so called deficiency diseases. These diseases are basically the functional disorders of living organisms. (e.g. iodine deficiency – hyperthyroidism, zinc deficiency – dwarfism, etc.)

Especially the most delicate parts of the living organisms, the nervous system and the hormonal and enzymatic processes react in a noticeable way to the absence of the so called rare bio-trace elements. A distinct group of elements is made up by heavy elements accumulating in the inner geosphere. These elements are so far from the biosphere of the earth's material system that they took part in the formation and evolution of life only in a low concentration. In the lithosphere, these elements represent an amount of only 1 g or less/ton. In case they happen to get into the biosphere through the geospheric activity of the earth and their concentration rises, they become toxic for several life forms. In terms of living material's functioning, these elements, for instance cadmium, lead, chrome, nickel, and mercury are qualified as especially toxic. Their presence is unwanted for living organisms. The higher order of living organisms requires only minuscule amounts of heavy elements like molybdenum or copper. However, if these elements get into living organisms more often and in a higher concentration, they cause functional disorders similar to toxic elements. According to the above mentioned things, it is obvious that for human beings, as the most advanced form of living material, only some favoured elements of the earth's material system are necessary and only in a well-defined amount.

According to today's knowledge, among the elements found in the earth's biosphere, human beings need only the following elements:

6 primary bio-elements: H, O, C, N, S, P

5 secondary bio elements: Fe, Mg, Ca, Na, K

18 bio-trace elements:
Li, B, Cl, Al, Si, Ti, Cr, Mn, Co, Cu, Zn, Se, Br, Mo, I, Bi, Rb, V

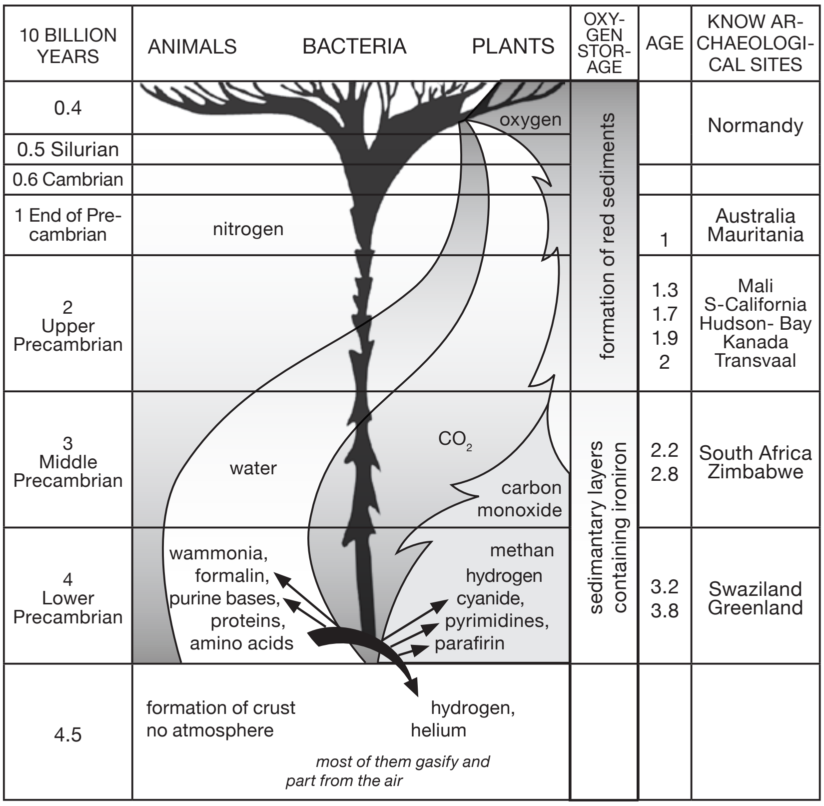

Figure No. 5 The outline of the atmosphere and the biosphere's temporal evolution

Therefore, altogether 29 elements are required for an undisturbed functioning by the higher order of living organisms. In terms of health care, it is a fundamental question whether these elements are available in a required concentration and in an eligible form for living organisms or not.

Remunerative characteristics of zeolites

1. Biogenic gas adsorption

The peculiar inner structure of natural zeolites is suitable for a quick, reversible adsorption of CO_2, NH_3, H_2S, SO_2 and H_2O molecules. Therefore, for example 1 g of suitably processed grist of zeolite content can adsorb nearly 100 ml of regular ammonia.

2. Ion exchange

The inner pore space is electrostatically unbalanced. Its cations can be exchanged in the affinity order of cations. By doing so, they can take part in the metabolism of living organisms; they can contribute to the ion exchange of cells and tissues, in plants by root-hairs and in animals on the surface of the digestive system.

3. Toxic heavy metal trap

Certain pathogenic species of bacteria link extremely strongly to zeolite structures. Therefore, for instance, zeolite suspension is suitable to inhibit the embryonic stages of staphylococcus or E-coli bacteria contents. Thus, natural zeolites can have a function not only in industrial livestock farming, but also in solving current problems of human health care. Beside their absorbance, the ion exchange of zeolites is capable to cause membrane disruption in the cell membranes of certain bacteria. This membrane disruption inhibits the embryonic stages of meningococcus and streptococcus, for example. Therefore, natural zeolites can offer new, selective ways of disinfection.

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5. Anti-parasite effect

The gametes or oocysts of certain parasites suffer membrane disruption in their cell wall when contacting zeolite crystals. Subsequent to a few hours of zeolite treatment, the gametes of certain parasites are unable to enter the embryonic stages and they die. Therefore, with zeolites, one can easily tackle human and animal health care problems without using chemicals or other foreign substances.

6. Catalyst effect

In a humid environment, in natural living systems or in the ground, zeolites of extremely large surface and pore space act as catalysts. They contribute to the metabolism between organic and inorganic materials. They can increase the activity of plant- and animal absorption systems

7. Bio-coherence

Zeolites are mineral systems formed in low pressure and temperature; they are substantial attributes and necessary parts of the environment of the earth's living material. The bacterial flora of living organisms is resistant to zeolite minerals. These minerals can be ingested without damaging living organisms and their systems. This property not only ranks zeolite minerals as coherent substances, but it also makes them suitable for use both in the pharmaceutical and food industry.

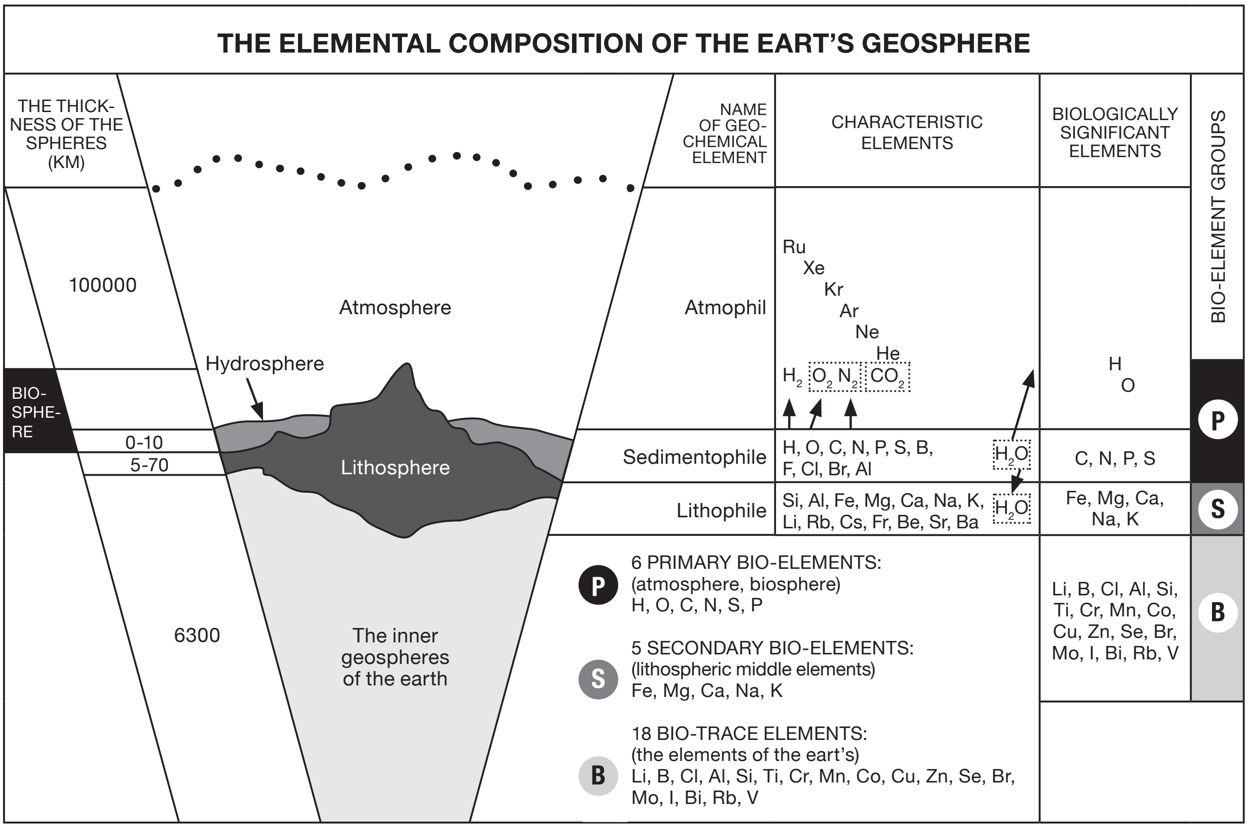

Figure No. 6

8. High albedo

In a large mass, the crystals of natural zeolites in their microcrystalline state are characterized by an albedo of 75-80%, which makes them suitable for satisfying the light requirements of a stock of plants, but they are also fit for manufacturing sunscreen products.

9. Adsorption heat generation

By the repeated saturation of zeolites with a dried out pore space, the energy required to ’clean’ them is partly released as thermal energy. Therefore, the rocks containing zeolite or their pores act as energy storages to a lesser extent.

10. Content of bio, trace and rare elements

The acidic volcanic glass that inevitably accompanies zeolites contains a whole range of biologically significant trace elements. These elements, which are important for living organisms, can be extracted from zeolite rocks. Both developing tastes and aromatic substances and treatments of trace element deficiencies of the nervous system can be based on this characteristic feature.

The characteristic features listed above are not separate, but additional beneficial effects. This, in particular, lays the foundations of natural zeolite rocks’ wide scope of utilization. These days, the scope of utilization includes lots of different things from amelioration works to human medicine.

The inevitable co-minerals of zeolite minerals are clay minerals. These also have physiologically beneficial characteristic features. The clay minerals that can be found in the mountains are the results of two genetic occurrences. In the first case, we calculate upon increasing clay mineral content alongside with the decreasing of the zeolite phase by the further degradation and crumbling of zeolite rhyolitic tuff. In the second case, deposits originating from the clay mineralized pedosphere of limnic lakes (as a result of post volcanic activity) have to be taken into consideration.
Beside the four Hungarian zeolite mines, in terms of the production of health care and beauty treatment products, kaolin, bentonite and illite occurences of limnic genetics play an important role. The important characteristic features of loose structure silicates are summarized in the following chapter:

Silicates

Silicates make up 50-70% of the uppermost layer of the earth’s crust. They are the most common minerals on the surface of the earth.

From a physiological aspect, water bearing hydroxide radicals and loose structure silicates have to be taken into consideration. In terms of medical treatments, their significance is extraordinary.

Their grid structure has diverse varieties. Quartzes are durable and they dissolve poorly; they mostly make up the framework of the earth’s crust. Their easily dissolvable parts are made up by weakly bound cations.

Among the silicates, there is a physiological and medical significance to those which are made up by SiQ4 tetrahedrons like quartzes of highr esistance. However, these tetrahedrons are organized into layers, where molecules of water or relatively easily dissolving elements are nestled. Loose silicate structures containing water, like montmorillonite, illite and zeolites (opposite to quartz) are soft, often oily. Such structures have a special significance in terms of cleansing and disinfecting (to a certain extent) human skin.

By placing such minerals that promote the absorption of water, there is a possibility to extract water from the outer layer of the skin, moreover, depending on the stretch of time, even from deeper skin layers, too. By extracting water, we can also extract undesirable toxins along with it. This conception is the basis for the treatment of tumidity, arthritis and haematomas, because the solutions, which flow from a less concentrated form to a more concentrated one, can be extracted from the skin surface along with the undesirable materials the solutions may contain; for example organic compounds causing body odour or watery intercellular solutions around inflammations.

Another characteristic feature of layered silicate minerals is their siccative effect. This fact establishes the various uses of medical talcum powders.

The silicate mineral powders of high absorbency interfere with the functional mechanism of microorganisms’ cellular membrane. According to repeated observations, stapihlococcus and streptococcus bacteria poorly tolerate dry mineral powders. It means that they disrupt the embryonic and reproductive stages of these bacteria. Disrupting the reproduction of infectious and pyogenic bacteria, for instance in case of pus discharge caused by external damage, brings about the reduction of the bacterial flora.

Another very important and outstanding medical characteristic feature of layered or zeolithic silicates is, that they are capable to transfer the cations carried in their layers towards the skin and other parts of the body, for instance villi, etc. This fact is the basis for the favourable enteral characteristic features of powders containing zeolite and clay minerals dosed through the digestive system. Among other things this phenomenon 23 is based on the fact that these minerals along with a diversity of bacteria inhabiting the human body are tolerated by our digestive system and our skin.

However, this does not apply to nosogenic bacterial flora. Consequently, by dosing clay minerals, zeolites and detrified volcanic glass may bring about a selective effect. We should highlight that the antiseptic chemicals generally known and recognized as medicine, do not differentiate between the body's own bacterial flora and nosogenic bacterial flora.

The products of 'Zeomineral Products' consist of a mixture of the above described natural minerals. Our product groups were assembled considering the useful and important physiological characteristic features of the mineral components.

'Zeomineral Products' is the premium category product line of Geoproduct. In addition to the above described natural mineral raw materials, they solely contain bio-coherent additives. The products are manufactured from hand-picked raw materials regulated by a strict quality assurance policy.

Zeomineral products can be purchased only through a direct marketing system.

Compiled and complemented by Szabolcs Mátyás; based on the works of Dr. Ernő Mátyás (1935-2012), Candidate of Earth Sciences, non-medical practitioner awarded with 'pro natura et vita' prize, geologist, university professor.

The effects of secondary bio-elements on plant life and the human body

BIO-ELEMENTS	FOR PLANTS	OCCURENCES	FOR HUMANS	NECESSARY DAILY INTAKE	HUNGARIAN ZEOLITE MINES (RÁTKA V. / RÁTKA VII. / MEZŐZOMBOR II. / MÁD III.)
Iron (Fe) Geochemical group of elements: **Siderophile** Characteristic mineral: **Hematite Fe_2O_3**	It has an important role in **photosynthesis.** It colours soil yellow, brown or red. Its **absence** is indicated by young leaves turning yellow or white, showing the signs of **iron deficiency.** As a reaction to a treatment of foliage fertilization with drugs containing iron-chelate, the leaves quickly turn green but thanks to the low mobility of iron, only those, reached by the spray.	chitter-lings, red meats, peaches, walnuts, beans, oat flakes, yolk	A mineral that is **indispensable for life. One of the constituents of our blood's haemoglobin, it encourages growth; it boosts our resistance to infections.** Women lose twice the amount of iron than men do. It reduces tiredness; it eases PMS and improves concentration. Deficiency symptoms: **exhaustion, dizziness, fatigue, hair loss,** paleness, lack of appetite, frequent infections, reduced coordination skills, learning difficulties.	15 mg	Fe_2O_3 1.82-5.53%
Magnesium (Mg) Geochemical group of elements: **Lithophile** Characteristic mineral: **Magnesite $MgCO_3$ Olivine $(FeMg)_2SIO_4$**	Sand contains only insignificant amounts of magnesium. Acidic soils also contain only small amounts. Magnesium ions move easily in the soil thus they often get eroded. Its lack hinders the uptake of phosphorus. Magnesium as a **constituent of chlorophyll** is **essential for photosynthesis.** Its lack is indicated by the appearance of spreading light spots among the leaves' veins which later wither.	figs, lemons, grapefruits, apples, dark green vegetables, almonds, walnuts	Magnesium is a material that protects the nervous system. It is necessary for the functioning of nerves, muscles, and the cardiovascular system, the metabolism of proteins, fats and carbohydrates, just as for the structure of bones. Its lack causes increased **fatigability, neurological problems** and metabolic disorders; blood circulation may also deteriorate. A change in personality, **muscle cramps, anorexia,** and nausea may also occur as symptoms. It prevents the formation of bile stones and renal stones containing calcium. It is also responsible for making use of vitamin C.	300-350 mg	MgO 0.17-2.52%
Calcium (Ca) Geochemical group of elements: **Lithophile** Characteristic mineral: **Calcite $CaCO_3$ Apatite $Ca_5(PO4)_3$ F, OH, Cl**	It has a crucial role in treating hard ground. In plants, it has low mobility, it accumulates in older leaves. **Its abundance prevents growth,** decreases the permeability of cell membranes. If it is surplus, it may cause a lack of potassium and magnesium. In young leaves its excess causes chlorosis and older leaves become a darker shade of green.	larger quantities can be found in dairy products, oilseeds but absorption is not adequate from the latter	It has an important role in **blood coagulation** and decreases the symptoms of allergic reactions. Its lack makes bones lose calcium, causing them to become weaker. The acidification of the body or a high intake of proteins may increase the emptying of calcium by urinating. Inadequate uptake may cause cardiac arrhythmias. Its lack is indicated by **muscle cramps** in adolescents and adults. The prolonged inadequate intake is indicated by rickets (lack of vitamin D) in children and **osteoporosis** in adults. It may be used as a treatment for irritability, concentration impaired and sleep disorders. To prevent muscle cramps, beside magnesium, calcium can also be used.	Young people: (15-18 years) 1000-1200 mg Adults: 800-1000 mg Pregnant/ breast-feeding women: 1200 mg Treating and preventing osteoporosis: 1200 mg	CaO 1.11-6.67%
Sodium (Na) Geochemical group of elements: **Lithophile** Characteristic mineral: **Rock salt NaCl**	Sodium is a harmful element because of **salinification** — the deterioration of soil structure. It may be used as a potassium supplement for tomatoes.	carrots, artichokes, shell-fish, kidneys, bacon	**Sodium and potassium are indispensable parts of vital processes.** Sodium helps to keep up the levels of potassium. Its excess makes potassium levels decrease and causes high blood pressure. It supports the adequate functioning of muscles and nerves. It has a vital role in maintaining osmotic pressure along with the help of potassium.	1-2 g	Na_2O 1.18-3.54%
Potassium (K) Geochemical group of elements: **Lithophile** Characteristic mineral: **Sylvinite KaCl Orthoclase $KalSi_3O_8$**	Plants obtain it by clay minerals. Potassium ions have great mobility. Potassium intake increases **the osmotic values** of cells, improves the absorption of water, and enhances water retention. Its lack makes plants wither, **the edge of leaves turn yellow.** Leaves that suffer from a lack of potassium are small (in case of new offshoots) and its overdose causes the plants to wither and dry up.	tomatoes, horseradish, bananas, mint, sunflower, potatoes, cabbages, fish	Potassium, along with sodium regulates the **fluid balance** of the human body and **heart rate.** If sodium-potassium balance is shifted, it causes nerve and muscle disorders. Low levels of potassium are indicated by loss of appetite and **nausea.** Most of our food contains enough potassium; its defiency is very rare under normal, healthy circumstances.	2-3 g	K_2O 0.89-3.43%
Lithium (Li) Geochemical group of elements: **Lithofil** Characteristic mineral: **Spodumene $LiAlSi_2O_6$**		fish, milk, dairy products, eggs, potatoes, vegetables	**Mental disposition,** manic depression; it is not an essential nutriment (in normal nutrition multiple amounts of the necessary dose get in the human body, no extra intake is required).	20-30 mg	an average of 50 ppm

The effects of rare bio-trace elements on plant life and the human body

RARE BIO-TRACE ELEMENTS	FOR PLANTS	OCCURENCES	FOR HUMANS	NECESSARY DAILY INTAKE	HUNGARIAN ZEOLITE MINES (RÁTKA V. / RÁTKA VII. / MEZŐZOMBOR II. / MÁD III.)
Boron (B) Geochemical group of elements: **Sedimentophile** Characteristic mineral: **Ulexite $NaCa[B_5O_6]OH_6$**	The lack of boron may happen in a loose, sandy and chalky ground. Leaves may become thick and fragile; the stem may also become fragile. The blooms fall down, calyx leaves dry up and an exterior suberification may arise; **the vascular bundles perish** — the part from the damaged spot to the shoot tips dried out. It stimulates the sprouting and growth of the pollen tube. In case of boron poisoning the shoot tips wither and the calyx leaves become twisted and they also dry off.	milk, seafood, savoy, cabbage, salmon, sesame seeds	**It decreases the emptying of calcium and magnesium,** thus helps osteogenesis and prevents osteoporosis. It is an essential element of cell division and hormonal regulation. **It hinders the thyroid gland's uptake of iodine** so its overdose may cause goitre. It plays a role in regulating blood-sugar levels.	3 mg	an average of 4 ppm
Iodine (I) Geochemical group of elements: **Sedimentophile** Characteristic mineral: **mineral sea water: IO_3 (0.06 mg/l)**		mussels, lobsters, salt-water fish, sea salt, milk	It is a part of the hormones produced by the **thyroid gland** which are crucial for the regular development of the human body. It takes part in the regulation of our metabolism; it influences growth and the operation of the nervous system. Its lack causes our metabolism to slow down, **depression arises,** the lipid levels in blood serum ride and cretinism in young children may occur. In pregnant women, **it may cause the foetus to die or spontaneous abortion** or foetal malformations may happen. Its general symptom is goitre, the enlargement of the thyroid gland.	0.15 mg	- / - / - / -
Chlorine (Cl) Geochemical group of elements: **Sedimentophile** Characteristic mineral: **Rock salt NaCl**	Since it is a strongly linked to sodium (salt), it harms soil structure by making it.	common salt, olives, sea algae	It can be found **in tissue water** and gastric acid. As a component of hydrochloric acid in gastric acid, it supports and prepares the digestive process. In intercellular spaces it bounds with sodium and potassium ions. Nowadays, our nutrition is adequate so no deficiency can occur. In a gaseous form it causes immediate and severe poisoning and harm if inhaled. It regulates the acid-base balance of our blood.	600-3000 mg, depending on age	0 / 0 / 0 / 0
Bromide (Br) Geochemical group of elements: **Sedimentophile** Characteristic mineral: **Bromides Lithium bromide LiBr**	It is a transitory element in inland crops.	apples, garlic, rice, cereals, horsetail, beans, green peas	It has a beneficial effect on the nervous system and **it reduces blood pressure.** Its compounds are used as tranquilizers in the pharmaceutical industry.	n/a	0 / 0 / 0 / 0
Silicon (Si) Geochemical group of elements: **Lithophile** Characteristic mineral: **Silicates SiO_2 Quartz**	Its lack causes weak growth. It is incorporated into the walls of plant cells, **it reduces the harm caused by green-fly aphis,** and it is also used as **fertilizer spray.**	apples, garlic, rice, cereals, horsetail, beans, green peas	There is a close connection between silicon and cell respiration and it has a vital role in bone maturation. In a small amount it is needed for collagen and **cartilage synthesis** and also for retaining **the water-content of the connective tissue.** To relieve bowel troubles, silicon is used in the form of colloidal silicon dioxide which, thanks to its large surface, is able to bind pathogens abiding in the intestinal canal.	21-46 mg	SiO_2 70-75 %
Titanium (Ti) Geochemical group of elements: **LIght pegmatophile** Characteristic mineral: **Ilmenite $FeTiO_3$ Rutil TiO_2**	As a foliar fertilizer, it has **a favourable effect of increasing the size of the crop** (grapes and tomatoes). It increases chlorophyll levels.		It causes gain in weight and increased height.	n/a	Ti O_2 0.19-0.54%

The effects of rare bio-trace elements on plant life and the human body

RARE BIO-TRACE ELEMENTS	FOR PLANTS	OCCURENCES	FOR HUMANS	NECES-SARY DAILY INTAKE	HUNGARIAN ZEOLITE MINES (RÁTKA V. / RÁTKA VII. / MEZŐZOMBOR II. / MÁD III.)
Chromium (Cr) Geochemical group of elements: **Light pegmatophile** Characteristic mineral: **chromit $FeCr_2O_4$**	Chromium does not belong to the essential plant nutrient, however, it may have a bio-positive effects in a small dose. In most cases, the chromium content of roots is much higher than that of shoots. The produce and the seeds contain the smallest amount of chromium. An amount of 1-10 mg/kg causes signs of poisoning: the shoots winter, young leaves become chlorotic, it inhibits root growth and taking up essential elements.	meat, liver, legume seeds, yeast, onions, shellfish, potatoes, mushrooms	As chromium plays an important role in the breakdown of glucose, it is essential for the normal functioning of the body's energy balance. Supporting the synthesis of cholesterol, fats and enzymes and weight loss is also very important. It helps stabilize blood sugar levels by an adequate use of insulin, so it is a useful trace element for those suffering from hypoglycaemia and diabetes. Chromium is far the most important mineral in the breakdown of glucose. Unfortunately it is not present in our bodies in the right amount; it may also be completely absent. This is caused by: natural chromium found in our food is poorly absorbed; we eat little food that contains chromium; during digesting food, chromium is often lost; due to a high intake of sugar, the chromium reserves of our body decrease. Ingesting a great amount of refined sugar, white flour and other unhealthy food makes it harder to keep our blood glucose levels moderate. The lack of chromium leads to exhaustion, nervousness, glucose intolerance (mainly with diabetic people), an inadequate breakdown of amino acids, and arteriosclerosis. Chromium, as a mineral, may be used for preventing the following disorders: obesity, hypoglycaemia (low blood sugar), stroke, higy bloodpressure, Crohn's disease, colitis, ulcer, gastritis, sclerosis multiplex, migraine, psychiatric disorders.	200-600 mg	20 / 70 / 80 / 80 / ppm
Manganese (Mn) Geochemical group of elements: **Licht pegmatophile** Characteristic mineral: **Rodocrozithe $MnCO_3$** **Pyroluzite MnO_2**	It is **an important component of hormones and enzymes.** Its lack makes older leaves lighter with green spots along veins. Younger offshots wither. **Its symptoms are similar to iron deficiency.** The chlorosis advances from the edges of the leaf towards the main veins. Its lack occurs in mainly soils rich in peat and humus. **Peach, plums, sour cherry trees and raspberry bushes are sensitive to its lack.**	walnuts, peas, carrots, cereals, oilseeds, yolk	It takes part in the processes of metabolism as the structural element of several enzymes. It has a role in releasing energy from food, defence against free radicals, the process of blood coagulation and osteogenesis (vitamin K, which has a key importance in blood coagulation and osteogenesis, works only with manganese). As a structural element of **enzymes,** it takes part in the processes of carbohydrates and fat metabolism; in protein, **DNA and RNA synthesis** and in the production of the so called mucopolysaccharides.	2-5 mg	MnO 0.05-0.18%
Cobalt (Co) Geochemical group of elements: **Siderophile** Characteristic mineral: **Cobaltite CoAsS Smaltite CoAs Accompanying Nikkel**	In smaller quantities it has a beneficial effect on plants. It usually has a role in oxidative metabolism if there is too much cobalt; it is phylotoxic because of it competes with other metals. **Its overdose may cause a lack of manganese and iron.** It may accumulate on the edges and tips of leaves. The cobalt content of individual plants may vary widely.	liver, kidneys, seafood, milk, spinach and grain legumes	The lack of **vitamin B12** may cause pernicious anaemia, myasthenia, bowel troubles, and disorders of the nerve track. Cobalt is a component of the vitamin B12 molecule. **It is essential for the formation of red bloodcells.** It prevents anaemia. If it is applied in a large dose for a long time, it prevents the thyroid gland from taking up iodine, so it leads to goitre.	0.0001 mg	6 / 7 / 9 / 9 ppm
Copper (Cu) Geochemical group of elements: **Sulcochalcophile** Characteristic mineral: **Chalcopyrite $CuFeS_2$**	It is an important component of **enzymes,** it is essential for chlorophyll formation. **Its lack causes chlorotic lesions like iron deficiency** — leaves are twisted, they become brown and they are shed. It occurs in loose soils.	liver, lettuce, cabbage, cauliflower, plums, peas, dried beans	Cupper is a vital trace element. It supports **the formation of red blood cells** and it is needed for maintaining the matrix of connective tissues (collagen). The so called primary or innate immune response (for the immune cells killing pathogens) also requires the presence of copper. Iron is **turned into haemoglobin** in the presence of copper by the human body. If copper is scarce, iron cannot incorporate in haemoglobin, thus it causes iron deficiency anaemia. Besides, the immune response weakens and **the flexibility of the vein walls** decrease, the blood's cholesterol level increases which are one of arteriosclerosis' main predisposing factors.	For children: 0.6-1.2 mg • For adults 2-3 mg	3 / 2 / 1 / 4 ppm
Zinc (Zn) Geochemical group of elements: **Oxochalcophile** Characteristic mineral: **Sphalerite ZnS**	It is an important component of **enzymes;** it influences the formation of growth regulators. **Its lack causes dwarfism** in young offshoots. **The excessive phosphorus content of the soil may induce a lack of zinc.** It can be supplanted by spraying.	meat, liver, milk, foodstuffs, eggs, potatoes, bee pollen, sunflower seeds, pumpkin seeds, lentils, peas, carrots, spinach, cauliflower	It has an important role in regulating our metabolism, the functions of enzymes and helps to adjust the acid-base balance of our blood. It contributes to **healing processes, muscle operation** and presumably it also influences cerebral functions. Its deficiency symptoms are the predisposition to depression, loss of appetite, and **pale, oily and spotty skin,** white spots on nails. Severe lack of zinc minerals causes growth disorders (in children), susceptibility for infections, anaemia, testicular degeneration and reduced taste. If overdosed, it may cause thirst, dry throat, metallic taste, muscle and chest pain, nausea, vomiting and fever.	10-15 mg	11 / 12 / 14 / 9 ppm

The effects of rare bio-trace elements on plant life and the human body

RARE BIO-TRACE ELEMENTS	FOR PLANTS	OCCURENCES	FOR HUMANS	NECES-SARY DAILY INTAKE	HUNGARIAN ZEOLITE MINES (RÁTKA V. / RÁTKA VII. / MEZŐZOMBOR II. / MÁD III.)
Selenium (Se) Geochemical group of elements: **Sulcochalcophile** Characteristic mineral: **Berzelianite Cu_2Se** **Eucairite $(Cu,Ag)_2Se$**	It is a component of **enzymes,** in plants it is only a transport trace element which can be mobilized easily.	beef, mutton, venison, liver, kidneys, garlic, peas, seafood, Brazil nuts, coconut, cereals, dairy products, walnuts, sesame seeds, legumes, asparagus, yeats	It has a primary role in **stabilizing cell membranes.** It is also an **antioxidant** so it is efficient in fighting free radicals. It takes part in increasing the body's resistance, reducing stress. Its ability to counteract harmful radiation and carcinogens is being examined. The **lack** of selenium causes skeletal muscle degeneration and muscle degeneration which means that legs degenerate so gait and posture abnormalities are developed. It may also cause **impaired vision, amenorrhea, premature aging, and hair loss,** white spots on skin anaemia, and cerebral dysfuctions (synaptic transmission deteriorates). In case of viral infections, pregnancy and breast feeding, chronic diseases, alcoholism, organ transplant, epilepsy and Alzheimer's disease, a higher intake of selenium is needed. Selemium as a mineral takes part in emptying heavy metals because it **reduces the levels of mercury and cadmium.**	For children: 0.01-0.05 mg, • For adults: 0.08 mg	0.4 / 0.3 / 0.3 / 0.3 ppm
Molybdenum (Mo) Geochemical group of elements: **Heavy pegmatophile** Characteristic mineral: **Molybdenite MoS_2**	It activates enzymes and **regulates photosynthesis and respiration.** It does not mobilize in plants. Its lack may cause the accumulation of nitrate, it regulates nitrogen.	legumes, cereals, chitterlings	It is an essential component of the enzyme that makes use of iron. Molybdenum is **a vital trace element.** It has enzyme stimulating qualities. If there is more molybdenum in the body than needed, it prevents the absorption of copper. People suffering from Chron's or Wilson's disease, must ingest extra doses of molybdenum. It also incorporates into **dental enamel,** contributing to healthy teeth. It reduces the risk of caries.	For children: 30-250 µg, • For adult: 250 µg	<1 / <1 / <1 / <1 ppm
Bismuth (Bi) Geochemical group of elements: **Sulcochalcophile** Characteristic mineral: **Bismuthinite Bi_2S_3**			It is effective for **inflammatory diseases** (Sore throat, tonsillitis). It boosts the functions of the digestive system; it is an ingredient of drugs for treating skin damage and skin infections. Antibiotics can be replaced by bismuth.		0.1 / 0.04 / 0.19 / 0.07 ppm
Vanadium (V) Geochemical group of elements: **Light pegmatophile** Characteristic mineral: **Vanadate V_2O_5**	It takes part in the photosynthesis of chlorophylls. It has a fungicidal effect.	green beans, garlic, wine, oilseeds, parsley, seafood, cabbage, tomatoes	It is toxic in greater amounts but the tiny amount our body needs, supports insulin action (imitates **insulin action),** carbohydrate and fat metabolism, it **reduces cholesterol levels** and contributes to muscle growth. It is required for enzyme activity and fat metabolism. Its lack makes cholesterol levels increase. It can exert insulin-like action, thus less insulin is needed. Its lack also leads to reproductive disorders.	10-30 µg	23 / 91 / 91 / 47 ppm
Rubidium (Rb) Geochemical group of elements: **Lithophile** Characteristic mineral: **none (it can always be found beside potassium)**	It accumulates in the leaves of plants. In case of replanting **it is pumped back to the ground** to help young plants to develop. In mushrooms it is able to replace potassium.	it can be found beside potassium, mushrooms	Like lithium, it acts as an **antidepressant.** It incorporates into red blood cells.	1.1-2 µg	29.3 / 151.5 / 143 / 72.2 ppm

Use of raw materials in mines operated by Geoproduct

ORDER	TYPE OF RAW MATERIAL	SYMBOL OF RAW MATERIAL	COMPONENT CARRYING USEFUL PROPERTY: NAME	FORMULA	INDURATION	CRYSTAL FORM	DENSITY	USEFUL PROPERTIES	FIELD OF USAGE
1.	**QUARTZTITE**		limnoquartz (rock) hydro quartz (rock)	SiO_2 (amorphous)	7.0	—	2.6	solid, hard, wear-resistant	ornamental, gardens, ponds
2.	**KAOLIN**		kaolinite	$Al_2Si_2O_5(OH)_4$	1.0-2.0	triclinic	2.6	ceramic materials, white	porcelain manufacture
3.	**POTASSIUM TUFF**		sanidine adularia kaolinite	$(K,Na)AlSi_3O_8$ $KAlSi_3O_8$ $Al_2SI_2O_5(OH)_4$	6.5 6.5 1.0-2.0	monoclinic monoclinic triclinic	2.6 2.6 2.6	ceramic melting material, high porosity, high K_2O content	soil improvement, water filtering
4.	**IRON OCHRE**		limonite hydro quartz kaolinite	$Fe_2O_3 \cdot nH_2O$ $2Fe_2O_3 \cdot H_2O$ $Al_2Si_2O_5(OH)_4$	1.0-1.0 3.0-5.0 2.6	amorphous amorphous triclinic	3.3-4.0 3.0-5.0 2.6	colourfast, dispersible, Fe content	animal nutrition
5.	**BENTONITE**		montmorillonite	$(Na,Ca)(Al,Mg)_2Si_4O_{10}(OH)_2 \times 4H_2O$	1.0	monoclinic	2.0-3.0	water absorption, swelling aquifer, watertight, ion exchanger, film-forming, sludge forming	insulation, soil treatment
6.	**SEDIMENTARY ZEOLITIC RHYOLITE TUFF**		clinoptilolite mordenite devitrified volcanic glas	$(Ca,Na_2)[Al_2Si_7O_{18}] \cdot 6H_2O$ $(Ca,Na_2,K_2)Al_2Si_{10}O_{24} \cdot 7H_2O$	4.0 5.0 6.0-7.0	monoclinic orthorombic —	2.2 2.3 2.6	whiteness, large specific surface area, molecular filtering, carvable, easy to cut	animal nutrition, medical science, ornamental stones, water filtering
7.	**TRASS**		quartz devitrifizied volcanic glas	SiO_2	7.0	trigonal	2.6	free silicic acid binder	cement manufacture
8.	**RHYOLITE TUFF** (LAND)		limonite quartz partially swollen volcanic glass	$Fe_2O_3 \cdot nH_2O$ SiO_2	1.0-5.0 7.0	amorphous trigonal	3.3-4.0 2.6	solid, hard, carvable, easy to cut, colourful	carving stones, building stones
9.	**RHYOLITE**		quartz orthoclasse	SiO_2 $KAlSi_3O_8$	7.0 6.0	trigonal monoclinic	2.66 2.5	solid, hard, carvable, colourful	building stones, ornamental stones
10.	**MOTTLED CLAY** (PLEISTOCENE)		illite quartz powder kaolinite	$K(H_3O)Al2[SiO_3AlO_{11}](OH)_2$ $Al_2Si_2O_5(OH)_4$	1.0 1.0-2.0	monoclinic triclinic	2.6 2.6	plastic, mouldable, bakeable	ceramics manufacturing

TYPE OF INDUSTRIAL RAW MATERIAL

ORDER	COSMETICS	FOUNDRIES, METALLURGIES	CERAMICS	ANIMAL HUSBANDRY	PHARMACEUTICALS	ENVIRONMENTAL, PROTECTION	CONSTRUCTION INDUSTRY	AGRICULTURE
1.		■					■	
2.	■		■		■			
3.			■			■		■
4.	■			■				
5.	■				■	■	■	■
6.	■			■	■	■	■	■
7.							■	
8.							■	
9.							■	
10.	■		■			■	■	