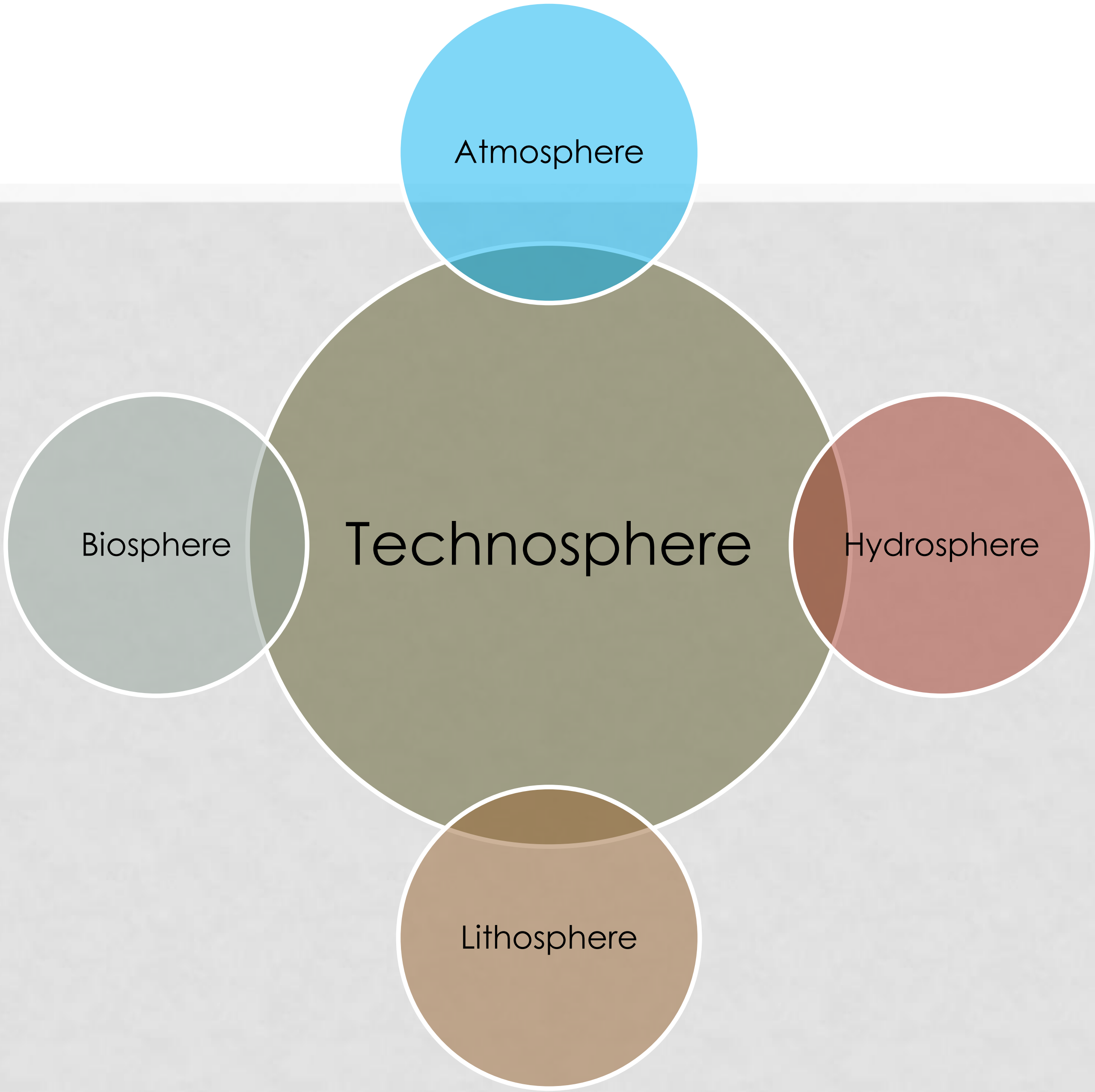
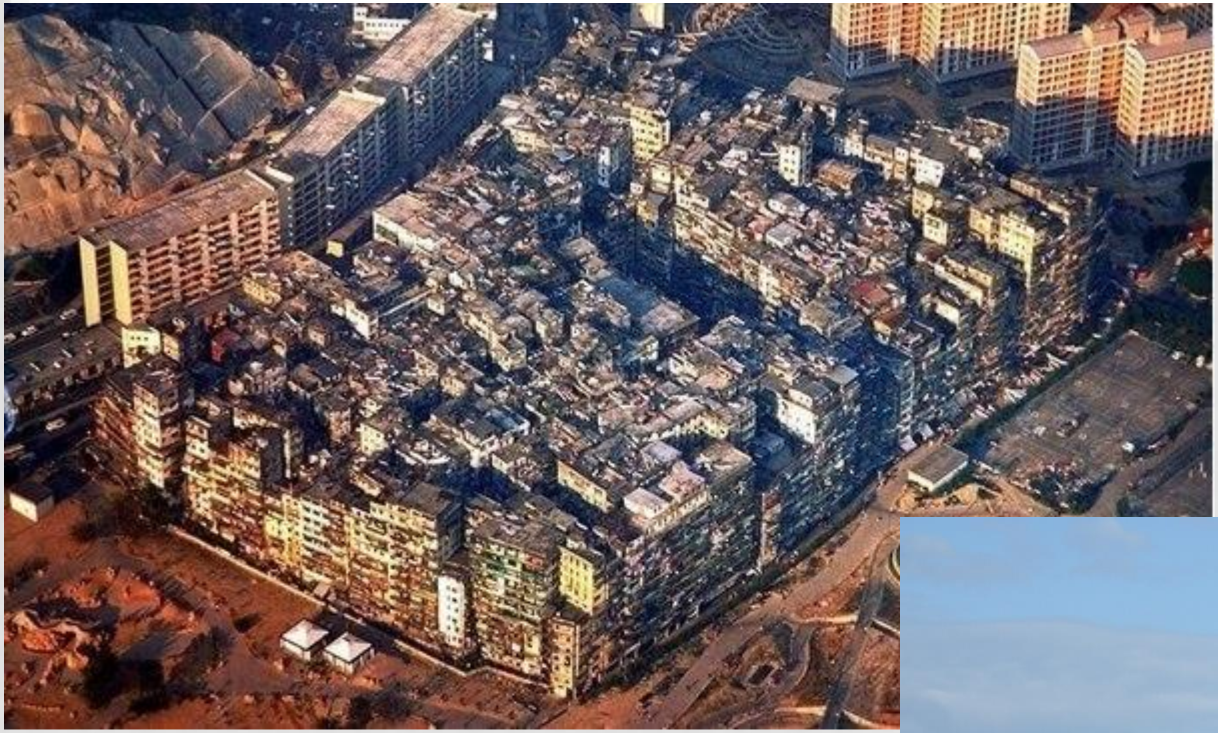

TECHNOSPHERE
Module course: Ecological geology

TECHNOSPHERE IS THE PART OF THE PHYSICAL ENVIRONMENT AFFECTED THROUGH BUILDING OR MODIFICATION BY HUMANS.

Technogenesis is the relation between humans origins and technology,
a total of geochemical and geophysical processes connected with human activity.

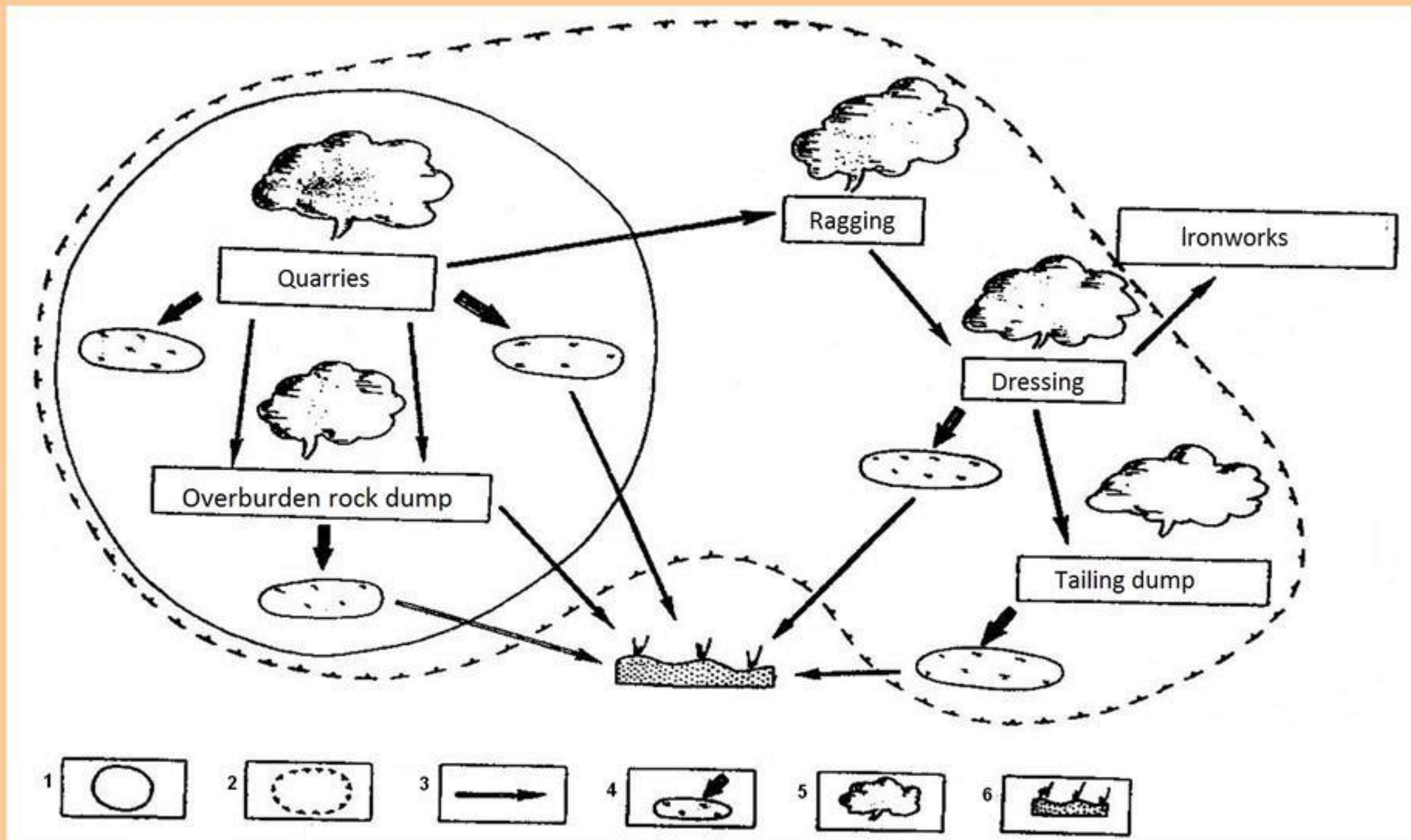

Atmosphere
Biosphere
Technosphere
Hydrosphere
Lithosphere

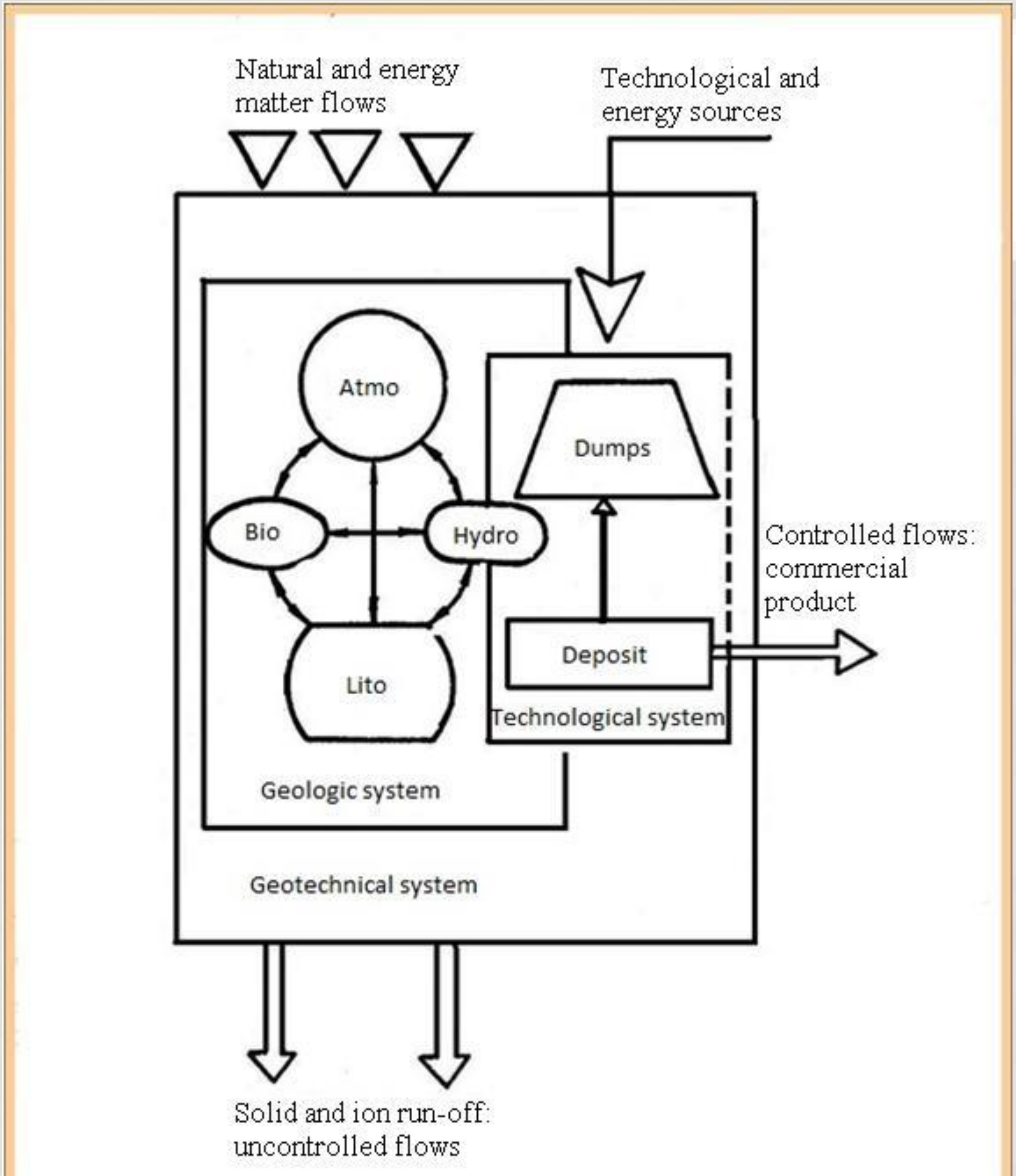
TECHNOSPHERE



TECHNOSPHERE STRUCTURE AND ROLE OF MINERAL RESOURCES IN ITS FORMATION

(E.N.VOSTOKOV ,1994)





SCHEME OF NATURAL AND TECHNICAL (GEOTECHNICAL) SYSTEM DURING MINERAL DEPOSIT EXPLOITATION

(E.F. EREMIN, 1991).

CLASSIFICATION OF ENVIRONMENTAL TECHNOGENIC DISTURBANCE DUE TO MINING PROCESSING IMPACT (A.A. PANICHEV, «MINING JOURNAL», №6, 1993)

Type	Technical process	Technogenic factor	Target area	Negative impact	Elimination of negative impact	
					Partial	Complete
1	Renovation	Removal of biologically active topsoil on site	Flora and fauna Soil	Destruction Withdrawal of farmlands	Usage of removal topsoil for other areas	Topsoil remediation not later than in three years
2	Stripping work	Developing significant trenches in the Earth crust	Subsurface Hydrology	Eradication of microorganisms Dynamical process and genesis abnormality Water regime abnormality	Waste disposals by covering of topsoil	Reclamation plus topsoil remediation
3	Waste disposals	Forming large -size dumps from unworkable rocks	Flora and fauna Soil Subsurface Hydrology	Destruction Withdrawal of farmlands Microorganism, dynamical process and genesis abnormality Water regime abnormality	Waste disposals	Implementation and development of high and alternative technology Mineral resource production from dumps
4	Drilling	Cylindrical boring	Atmospher e	Dust pollution Gas contamination Water regime	Air aspiration Regime optimization	Water and emulsion drilling No jet-drilling rig

Type	Technical process	Technogenic factor	Target area	Negative impact	Elimination of negative impact	
					Partial	Complete
5.1	Mass blasting operation	Rock fragmentation on a large scale	Building zone Flora and fauna Atmosphere Subsurface Hydrology	Seismic hazard Extinction Gas contamination, dusting, noise Microorganism, dynamical process and genesis abnormality Water regime abnormality	Process optimization	
5.2	Secondary blasting operation	Fragmentation of isolated upland aggregates on a large scale	Building zone Flora and fauna Atmosphere	Seismic hazard, noise Extinction Gas contamination, dusting, noise	Process optimization of massive blasting operation	Usage of blastless crushing method
6.1	Mineral production without "volatile" in the structure	Making of considerable dugout in the Earth crust	Subsurface Hydrology	Dynamical process and genesis abnormality Eradication of microorganisms in the Earth crust Water regime abnormality	Process optimization of massive blasting operation Laying of mine goaf	Usage of blastless crushing method
6.2	Mineral production	The same	Subsurface	Dynamical process abnormality	The same	Processing

Classification of technological impact on the geological environment (Korolev V.A., 1985)

Class and subclass of effect	Type of effect	Type of effect	Geologic environment elements PGIVRD	Variety of effect	Effect results, unit of measure	Potential source of effect
1	2	3	4	5	6	7
Actual effect Mechanical effect	Compaction	Static Vibrocompaction Roller compaction Tamping Explosion compaction	PGI PGI D PGI PGI PGI D	Stand on the following grounds: 1. Time: constant and temporary; 2. Size: point, linear, areal, volume; 3. Location: ground, underground; 4. Reversibility: reversible, irreversible; 5. Goals: spontaneous, goal-seeking; 6. Intensity: low, medium, high	Pressure, mPa Amplitude and frequency, hz Specific energy, watts per square meter	Building, construction Vibro- machine Motor transport, rollers Subway Explosions
	Decompaction	Basic load Dynamic load	GI RD GI RD		The same	Mines, cavities Fore shaft, explosions
	Inner massive fragmentation	Drilling Grinding Trimming Detaching Spading and shovelling Explosive rupture Ploughing up and cultivation	GI GI GI GI PGI GI D P R		Depth of SKV Work, capacity, specific energy, watts per square meter	Bore wells Cutter-loaders Mine roadways Open-cut mining, open-cast Mines, stonedrifts Explosions Agronomic activity
	Relief accumulation	Waste pile dumping Discard dumps Banking Dam making	I RD I RD I RD I RD		Coefficient of variation, specific energy, watts per square meter	Mines TPS, HES, SDPP Concerns Construction
	Relief planning	Constructive and road planning Reclamation Slope terracing	PGI RD PGI RD G RD		The same	Construction Recultivated sites Amelioration sites
	Relief erosion	Dint forming Channeling and trenching Slope facing Formation of subsidence trough	PGI RD PGI RD G RD PIR		The same	Open-cut mining, open-cast Fore shaft, wormholes Road construction Mines

Class and subclass of effect	Type of effect	Type of effect	Geologic environment elements PGIVRD	Variety of effect	Effect results, unit of measure	Potential source of effect
1	2	3	4	5	6	7
Actual effect Hydromechanical effect	Relief hydro-accumulation	Dam hydraulic fill Hydraulic deposition of gold dump Hydraulic deposition of bourocks and solid masses	IVRD IVRD IVRD	on the following grounds: 1. Time: constant and temporary; 2. Size: point, linear, areal, volume; …tion: ground, underground; 4. Reversibility: reversible, irreversible; 5. Goals: spontaneous, goal-seeking; 6. Intensity: low, medium, high	The same	Construction TPS, HES Tailing dump Sludge storage pits
	Relief hydroerosion	Hydraulic washing-out of solid masses Sag- underwashing	GIVRD PGIVRD		The same	Open-cut mining, open-cast Diggers Water pumping, underground desalinization
Hydrodynamic effect	Pressure rising	Discharge pumping, injection Saturation Irrigation	V GIV PGIV D		Changes in source pressure, level and humidity Specific energy, watts per square meter	Pumping Blowing, industrial wastewater Agricultural watering, hydro- amelioration
	Pressure decreasing	Unwatering Dewatering Desaturation	V PGIV D PGIV D		The same	Drawing Amelioration sites
Thermal effect	Heating	Conductive (until 100 degrees) Convection (until 100 degrees) Firing (more than 100 degrees) Melting Heat hardening Biochemical	PGIV PGIV RD GI GI GI PGIV		Temperature, horizontal temperature gradient Deg/m Specific energy, watts per square meter	Blastfurnaces, TPS, APS, HEW, SDPP, hot shops Underground melting of sulphur, gasification Amelioration technical sites SDW landfills
	Cooling	Conductive Convection Freezing	GIV GIV PGIV RD		The same	Coolers Pumping Amelioration technical sites
…-magnetic effect	Spontaneous	Electric field inducing	PGI		Intensity, V/sm Density, A/m	Electric train lines Subway Tramway, trolley and electric lines
	Goal-seeking	Electrical machining	GI		The same	Amelioration technical

Class and subclass of effect	Type of effect	Type of effect	Geologic environment elements PGIVRD	Variety of effect	Effect results, unit of measure	Potential source of effect
1	2	3	4	5	6	7
Physico-chemical effect	Hydrate	Capillary condensation Dehydrotation	PGIV PGIV	The same as in physical effect	Moisture gradient	Asphalt coat Drainage systems
	Colmation	Physical Physico-chemical	PGI PGI		Colmatation volume, m3	Amelioration technical sites
	Leaching	Straight Diffuse	GIV GIV		Specific energy, watts per square meter	Leaching sites
	Ion-exchange	Solonized Ion-exchange	PGI PGI		Exchange capacity	Land amelioration
Chemical effect	Pollution	Phenolic, chlorophenolic Nitrate Pesticide Herbicide Heavy metals Hydrocarbonaceous Acid Alkali Salting	PGIV PGIV PGIV PGIV PGIV PGIV PGIV PGIV PGIV	The same	Pollutant concentration, MPC excess, volumetric rate of masstransfer	Chemical plants, farms, animal farming, refuse storages, agriculture, transport, emissions, gas-station, acid rains, oil storages, runoffs
	Treatment	Neutralization Desalinization Dilution	PGIV PGIV PGIV		The same	Land amelioration
	Massif stabilization	Cementaion Silicification Bituminous grouting Resinification Liming and others	GI GI GI GI GI		Volume, m3	Amelioration technical sites
logical effect	Pollution	Bacteriological Microbiological	PGIV PGIV	The same by the type of microorganisms	MPC excess, specific transfer speed	SDW landfills, farms, bins, sewerage
	Treatment	Sterilization	PGIV		The same	Objects of treatment

ELEMENT DISTRIBUTIONS ACCORDING TO TECHNOGENIC PRESSURE MODEL (N.F. GLAZOVCKY, 1982)

Technogenic pressure unit, (kg/km^2) year	Elements
500-1000	Na, Cl, Ca, Fe
200-500	S
100-200	N, K
50-100	Al
20-50	P
10-20	Ti, Mn
1-10	B, F, Mg, Cu, Zn, Zr, Ba, Pb
0.1-1	V, Cr, Ni, As, Br, Sr, Mo, Cd, Sn. I, U
0.01-0.1	Be, Sc, Co, Ga, Ge, Se, Bi
0.001-0.01	Li, Ag, W, Au, Hg, Tl
0.0001-0.001	Cs

Environmental component evaluation of open-cast and underground mining methods (V.S.Smirnov, 1995)

Environmental factors	Mining method		Separation
	Underground	Open-cast	
Area pollution at deposit production period	H-Cp	C	H-Cp
Air pollution	O	H	H-C
Water pollution	O-Cp	O-H	H-C
Noise pollution	H	H	H-Cp
Area pollution after deposit production period	H	C	O-H
Number of rocks entering into dumps as the result of one ton coal production, m^3	0,25	up to 4	
Zone affected on changing of basic natural environment components	1,0	10-100	
Yield decrease of agricultural plants at affected zone, %	No previous	10-30	

Comments: O – silent influence; H – small; Cp – average; C – strong.

RECYCLE RATE AND RECLAMATION OF SOME METALS

Metal	Recycle rate (1969), %	Usage		Associated products
		Good ejection	Bad ejection	
Aluminium	11.7	New scrap (81%), electric equipment, constructional materials and packing	Chemicals, catalytic reagents, refractory metals	Mg, Cu, Vn, D
Copper	40.9	Latten, bronze, alloy materials, coining, electrical equipment	Chemicals, fungicides, micronutrients	Zn, Sn, Pb
Gold	15.9	Alloy materials	Jewelry, electronic engineering, bullions	Ag, Pt group
Iron	27.9	New scrap (57%), constructional materials, transport and packing	Chemicals, fertilizers	Cr, Mn, Ti, C
Lead	40.0	Batteries, alloy materials based on Pb and Cu	Gasoline additives, pigments	Sb, Pb, Cu

Metal	Recycle rate (1969), %	Usage		Associated products
		Good ejection	Bad ejection	
Mercury	20.6	Hydrargyric boxes in the manufacture of chlorine, electrical equipment	Fungicides, sealants, colours	Organic elements, Ag
Nickel	19.1	New scrap	Corrosion resistant steels	Fe, Co, Cb
Silver	47.2	Coining, bimetallic scrap, current sources	Photographic preparations	Cu, Ni
Tin	20.4	Alloy materials based on Sn and bronze	Welding alloy, tins	Cu, Pb
Tungsten	4.1	Scrap of heat-resisting alloys, cutting tools	Fume from metal cutting, welding tacks, filament of incandescent lamp	Th, C
Zinc	27.0	New scrap (75%), latten, bronze, batteries	Galvanization products, pigments	Cu

GLOBAL EMISSIONS OF METALS TO THE ENVIRONMENT, CA. 1988, IN 10^{6} KG/ YEAR (DATA FROM REIMANN ET AL., 2003)

Metal	Weathering & volcanic (Azar, 1996, from Nriagu, 1990)	Total emissions (ex landfill)	Total chain losses (emissions + landfill)[a]	Emissions to air (Nriagu & Pacyna, 1988)	Emissions to surface water (Nriagu & Pacyna, 1988)	Emission to soil (Nriagu & Pacyna, 1988, landfill excluded)	Landfill mining/ smelter waste (Nriagu & Pacyna, 1988)	Other landfill	Ratio natural/ societal ex landfill	Ratio natural/ societal inc landfill
As	110.0	67.3	157.7	18.8	41.0	7.5	15.9	74.6	0.6	1.4
Cd	5.3	20.4	44.8	7.6	9.4	3.5	5.8	18.6	3.9	8.4
Cr	830.0	264.8	1068.5	30.5	142.0	92.4	–	803.7	0.3	1.3
Cu	380.0	242.5	2218.4	35.4	112.0	95.2	1117.0	858.9	0.6	5.8
Hg	1.4	10.1	18.3	3.6	4.6	2.0	1.9	6.4	7.2	13.1
Mo	15.0	34.4	116.2	3.3	11.0	20.2	13.9	67.9	2.3	7.7
Ni	300.0	227.7	585.2	55.7	113.0	59.1	91.5	266.0	0.8	2.0
Pb	290.0	505.1	1768.9	332.4	138.0	34.8	502.5	761.3	1.7	6.1
Sb	9.9	29.2	79.5	3.5	18.0	7.7	32.0	18.4	2.9	8.0
Zn	910.0	713.6	2601.9	131.9	226.0	355.7	872.0	1016.3	0.8	2.9

a) including mining/smelter waste

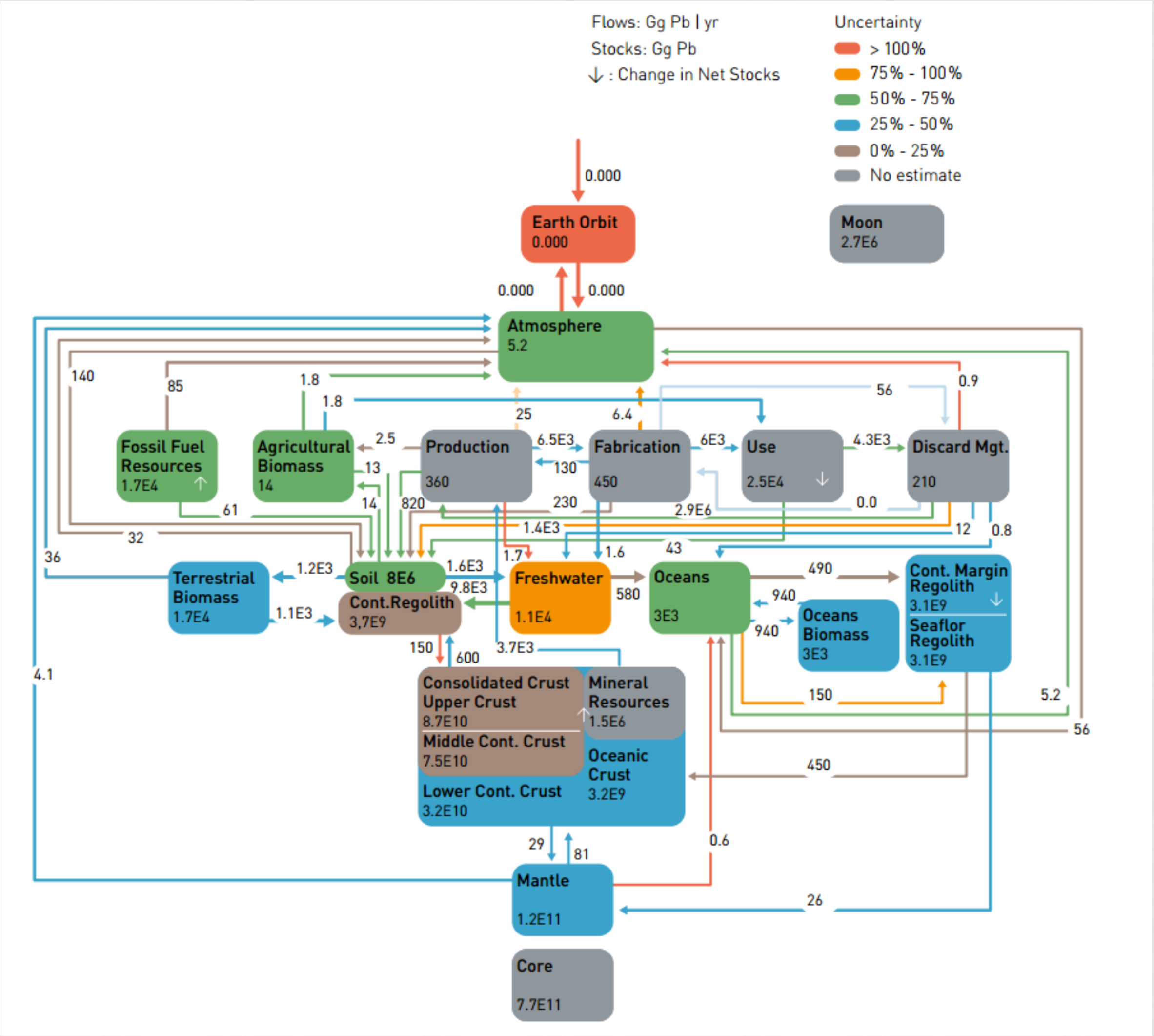
EMISSIONS AND LOSSES COMPARED TO ANNUAL PRODUCTION OF METALS, CA. 1988, IN 10^6 KG/YEAR

Metal	Total emissions ex landfill (Reimann et al., 2003)	Total emission inc landfill (Reimann et al., 2003)	Primary production (USGS, data for 1988)	Emissions over primary production (Reimann et al., 2003)	Total losses over primary production (Reimann et al., 2003)
As	67.3	157.8	61	1.1	2.6
Cd	20.4	44.4	20	1.0	2.2
Cr	264.8	620.5	3870	0.1	0.2
Cu	242.5	2218.4	8720	0.0	0.3
Hg	10.1	18.3	6.8	1.5	2.7
Mo	34.4	115.8	113	0.3	1.0
Ni	227.7	585.2	952	0.2	0.6
Pb	505.1	1820.9	3420	0.1	0.5
Sb	29.2	79.5	105	0.3	0.8
Zn	713.6	2601.4	6770	0.1	0.4

A COMPARISON OF ESTIMATED GLOBAL ANTHROPOGENIC EMISSIONS OF TRACE METALS IN THE MID- 1990S WITH EMISSIONS FROM NATURAL SOURCES (EMISSIONS IN 10^{3} TONNES/ YEAR) (NRIAGU, 1998; PACYNA AND PACYNA, 2001)

Trace metal	Anthropogenic emissions	Natural emissions (median values)	Ratio anthropogenic/ natural emissions
As	5.0	12.0	0.42
Cd	3.0	1.3	2.3
Cr	14.7	44.0	0.33
Cu	25.9	28.0	0.93
Hg	2.2	2.5	0.88
Mn	11.0	317.0	0.03
Mo	2.6	3.0	0.87
Ni	95.3	30.0	3.2
Pb	119.3	12.0	9.9
Sb	1.6	2.4	0.67
Se	4.6	9.3	0.49
V	240.0	28.0	8.6
Zn	57.0	45.0	1.3

STOCKS AND FLOWS OF LEAD IN NATURAL AND HUMAN RESERVOIRS, AND THE GLOBAL FLOWS OF METAL AMONG RESERVOIRS (RAUCH AND GRAEDEL 2007, RAUCH AND PACYNA 2009).



Technogenesis includes (geochemical aspect):

1. Chemical element extraction from natural environment (lithosphere, atmosphere and hydrosphere);
2. Chemical element transformation, element chemical composition changing and new chemical element;
3. Dissipation of elements involved in technogenesis into natural environment.

Negative technogenesis impact involves the concept **«environment pollution»**

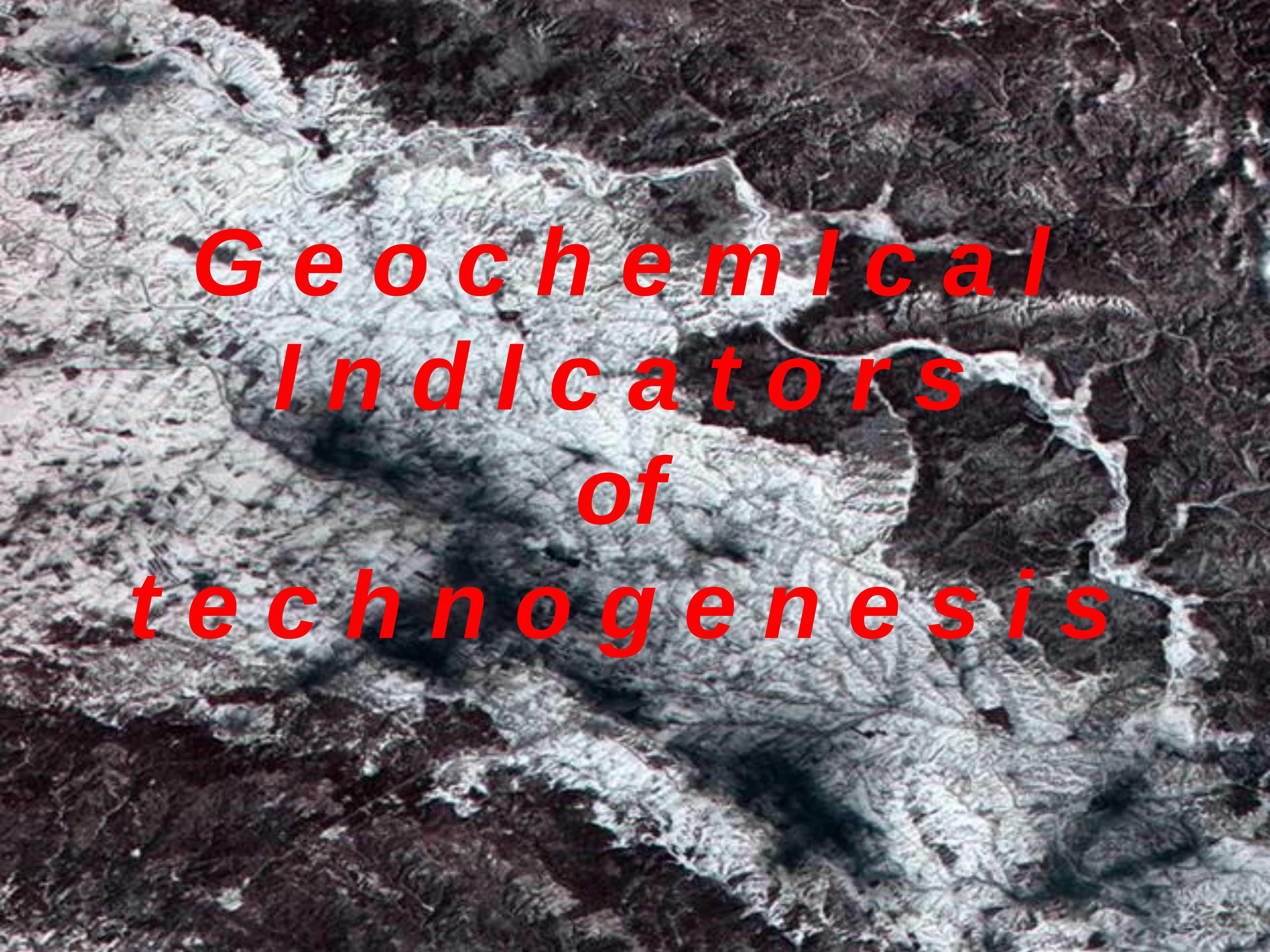
Environment pollution is a technogenesis product entering the environment and influencing human, biological components and engineering structures (destruction of buildings and underwater constructions).

According to B.I. Vernadsky's theory on leading geochemical role of living matter in the biosphere and composing its nonliving matter, the main area pollution criterion (or unpolluted criterion) can be state and functioning of living organism occurred in this system.

Fluctuation limits of technogenic substance concentration and its modes of occurrence in unpolluted nonliving systems have to conform to the following conditions:

1. Gas, concentrated and redox facilities of a system of living matter aren't diminishing and they control the geochemical system self-clarification.
2. Biochemical composition of primary and secondary production isn't changing. It cannot be the cause of vital dysfunction in some food links inside and outside a system.
3. Biological productivity of a system isn't decreasing.
4. System informativity isn't decreasing: genetic resource necessary to the system existence is saving.

Technogenic transformation of this natural system can happen as a result of the condition violation mentioned above. The system can be destroyed as a result of action level of technological impact.


GeochemIcal
IndIcators
of
technogenesis

Mass evaluation of chemical elements involved in the annual technogenic fluxes, and their comparison to the element masses involved in the natural geochemical fluxes (hydrochemical stream runoff, biological cycle) indicating the fact that since the 60's of the XXth century the geochemical activity of the mankind is equal to the forces of natural processes.

Humans extract annually many chemical elements from underground resources and those elements as a result of flaring or burning fossil fuels (especially coal). These quantities are equal or even greater than the amount that terrestrial vegetation consumes to generate their annual growth .

Chemical elements, annually involved in major global natural and anthropogenic fluxes of the biosphere (O.P. Dobrodeev, 1978)

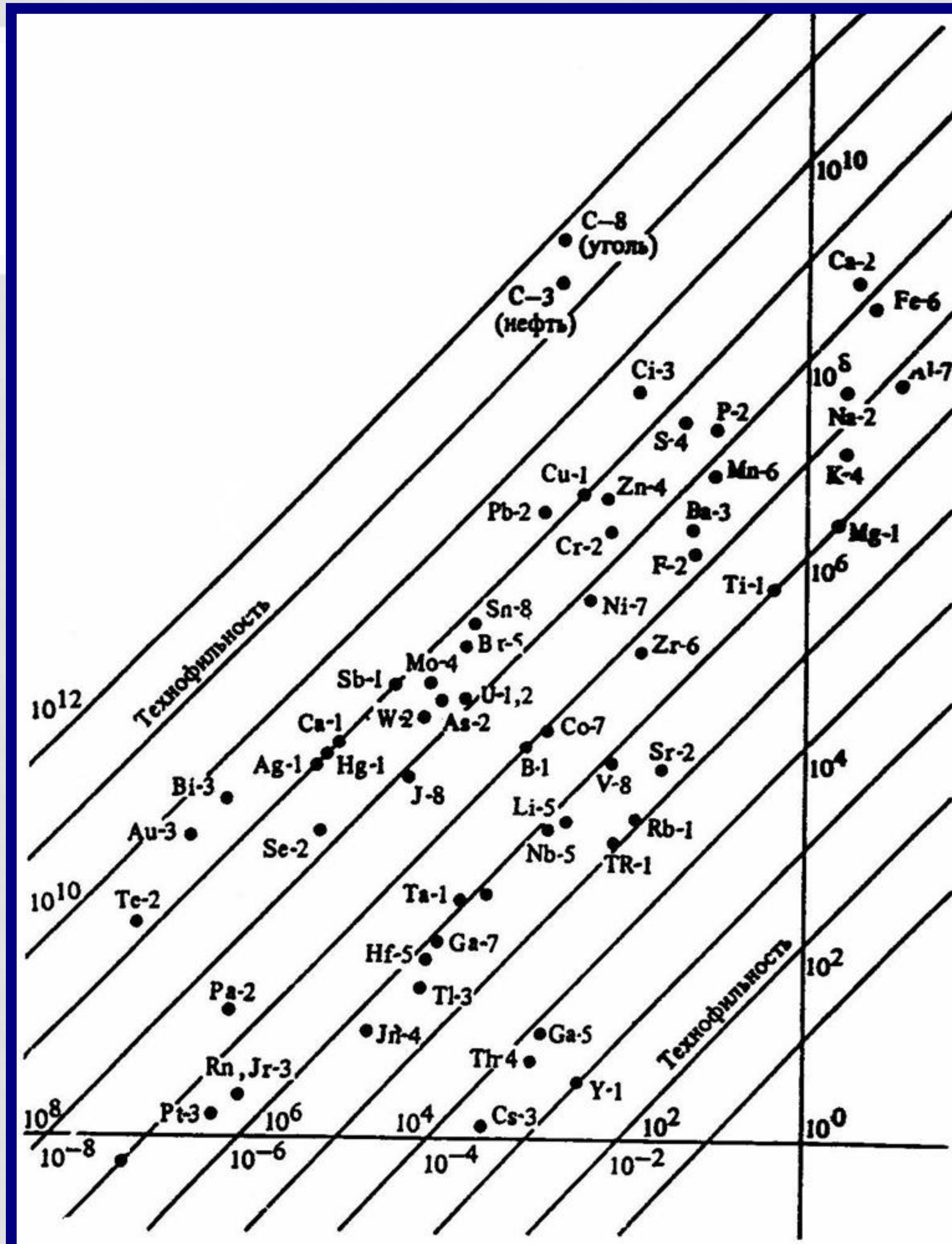
Quantity of chemical elements	Element subtraction in river flow	Assimilated in organic land products	World production	In burned combustible fuels
$n*10^{14}$		O		
$n*10^{10}$		C, N, H		O
$n*10^{9}$		Ca, K, Si	C	C
$n*10^{8}$	C, Ca, Mg, Na, S	P, Mg, Na, Al, S	Fe	Al, O, H
$n*10^{7}$	K, N, Fe	Cl, Mn, Sr, Fe	K, Na, S, O, C, I	Fe, Ca, S, Na
$n*10^{6}$	Sr, Al, Ba	Zn, Ti, B, Cr, Cu, Br, Pb, F, Al, Cl, Ba, Mg	P, Cu, Zn, Mn, Pb, F, Al, Cl, Ba, Mg	K, Sr, Ti, Na, Mg, Ba
$n*10^{5}$	Zn, Br, B, P, Ti, Mn, Ni, Cu, As, Zr	Ni, I, Ba, Ge, V, Ga, Rb, Mo, Co,	Ti, Ni, B, Sn, Br	P, Hg, Cr, Cu, Zn, Mo, Li, B, Ge, Be, U, Pb, La, Zn, As, M, N, V, Rb
$n*10^{4}$	I, Pb, Li, Co, Cr, Mo, U, Rb	Rb, Li, Pb, F, Zr, Sn, Y, Cs, Se, Be	Hg, As, Co, Mo, U, , Cd, Sb, W	Pb, I, Y, Ga, Sc, Bi, W, Hg
$n*10^{3}$	Ag, Cs, V	Ag, Au, Y, U, Th, Nb, As	Li, V, Se, I, Zr, Bi, Ag, Au, Be, Sr, N	Ag, Cd
$n*10^{2}$	Th		Ge	Au

Annually, much resources are extracted than being involved in the biological cycle: Cd - more than 160 times, Sb - 150, Hg - 110, Pb - in 35, As, F - 15, U - more than 6, Sn - 5, Cu - 4, Mo - 3 times. The mining of Ag, Cr, Ni, Zn is approximately equal to the annual vegetation consumption.

In ore mining trace elements are extracted, most of which are released or dispersed into the environment through coal burning. Each year, the burning of coal releases more chemical elements than is involved in the biological cycle: Hg – 87.000 times, As - 125, U - 60, Cd - 40, Li, Y, Be, Zr - 10, Sn, V - 3-4 times.

- Technophile is the element usage to its content ratio in the lithosphere
- The concept "element technophility" was introduced by A.P. Perelman (1973). Technophile indicator is the ratio of annual element extraction mass to its Clarke in the lithosphere.
- Technophile elements vary in time and depend on the use and extraction of certain elements.

Technophility of chemical elements
(A.I. Perelman, 1973)



The general noosphere development tendency involves an increase in technophility.

The highest global technophility - CL, C; relatively high - Pb, Sb, Zn, Cr, Sn, Mo, Hg;

this index does not completely reflect the chemical elements degree involvement in the technogenesis;

technogenesis excludes the invasion of elements into the environment, which are extracted with ores and energy resources (coal, crude oil);

chemical elements are involved in the technogenesis not only from the lithosphere, but also from the atmosphere (the synthesis of nitrogen fertilizers, etc.), from the hydrosphere (salt production, etc.);

these elements accumulate in organic matter (crops, wood, and all organic sea products).

Basic geochemical indexes of technogenesis

Index (coefficient) of special technogeneity:

$$N=(M_1+P_1)/\ n_n$$

where

M_1 is an involvement of an element in technogenic flows for special technogenic use;

P_1 is element transfer from the natural flows.

Index (coefficient) of the total element technogeneity:

$$N=(M_1+M_2+P_1+P_2)/n_n,$$

where,

M_2 element involvement into man-caused migration, as a result of element mobilization from immobility;

P_2 - its transfer from the natural flows, as by-products.

This index demonstrates the total element involvement degree in man-caused migration.

The element distribution to technophile index(N.F. Glazovskiy, 1982)

Index values	Technophile	Special technogeneity	Total technogeneity.
10^{11}			Au
10^{10}	Cl	Au	Ni, Bi, U
10^{9}	Bi, Au, Cd, Ag	Bi, Pb, Cu, Aq, Cd, W, Zr	Cd, W, Pb, Cu, Ag, I, Zn, As, Se, Mo, Zr
10^{8}	Pb, Br, Cu, Sn, Hg, S, As, N, P, Ca, Cr, Zn, Mo, Se, W, Na, U, I	Cl, Zn, Ba, Na, Mo, Sn, Cr, Ca, N, Fe, P, As, U, S, Mn, I, Ni	Cl, Ba, S, Na, Cr, Sn, Ca, P, Fe, Be, B, Ge, F, Ti, Ni
10^{7}	B, Fe, Mn, Ni, Ba, F, Ti,	Se, Br, Hg, F, B, K, Co, Cs	Br, Mn, Hg, Co, V, Ga, K
10^{6}	Zr, Co, Cs, K, Li, Mg, Al	U, Mg, Be, Al, Y, Ti	Mg, Li, Al, Tl
10^{5}	Ge, Be, V, Tl	Tl	
10^{4}	Sc	Sc	
10^{3}	Ga	Ga	

The sustainable use of involved elements in technogenesis can be expressed by **complete technogenic index (P).**

This index represents the percentage ratio between amount of specially extracted element and its total amount involved in technogenesis.

Complete technogenic index (N.F. Glazovskiy, 1982)

Element	Complete technogenic index	Element	Complete technogenic index
Cl	98	Ca	81
Na, Cu, Ag, Ba	91	Hg	77
Li, Fe, Pb	88	Br	71
Sn	87	P	55
Ni	86	Mn	54
Cr, Zn	83	Mo,F	45
W	43	Be	2,1
Cd	38	Si	n
B, Co	31	V	n
Bi	25	J	n
K	22	Ge	0,8
S	20	Sc	0,4
As, N	17	Ga	0,024
Al,U			
Se	7,1		

Index of technogenic fixation was recommended by N.F. Glazovsky to

characterize interconnection between technogenic geochemical migration and other migration processes;

indicate element stability in technogenic sphere:

$$K_{ф} = Q_1 + Q_2,$$

where,

$Q_1 = M_1 + P_1$ - involved element amount in technogenesis for a definite time period;

Q_2 - amount of trace elements in the same period of time.

The following expression shows **regional technogenic migration of accumulated substances (H)** as foodstuffs, raw materials, production equipment within this area**:**

$$\mathbf{H=P+M\pm\Delta-B}$$

where,

P - substance transformation from natural geochemical fluxes to technogenic ones;

M - immobile state substance is mobilized in technogenic geochemical fluxes;

Δ - resulting import-export of the substance in this area;

B - substance amount transform from technogenic fluxes to the environment.

If the element escapes fully and rapidly from technogenic fluxes (for example, fertilizers or during fuel burning), then $B= P + M \pm \Delta$.

The value **TD = *M* ± Δ** characterizes the technogenic **geochemical impact on the landscape.**

It demonstrates which additional elements escape from technogenic fluxes into the environment within one area.

Value TD - technogenic geochemical pressure, (S) - module of technogenic geochemical pressure: Dm(TD/ S).

Technogenic pressure is determined not only for pure chemical elements but also for their compounds.

Average technogenic pressure module can be determined by the element behavior in technogenic migration:

M/S,

where,

M - total amount of mobilized substances,

S - Earth surface area. This average module can be used as a reference in comparing technogenic chemical pressure in different areas.

ELEMENT DISTRIBUTION TO TECHNOGENIC PRESSURE MODULES (N.F. GLAZOVSKIY, 1982)

Technogenic pressure, module (kg/km2) year	Elements
500-1000	Na, Cl, Ca, Fe
200-500	S
100-200	N, K
50-100	Al
20-50	P
10-20	Ti, Mn
1010	B, F, Mg, Cu, Zn, Zr, Ba, Pb
0,1-1	V, Cr, Ni, As, Br, Sr, Mo, Cd, Sn. I, U
0,01-0,1	Be, Sc, Co, Ga, Ge, Se, Bi
0,001-0,01	Li, Ag, W, Au, Hg, Tl
0,0001-0,001	Cs

Total indexes of noosphere concentration of some products (N.F. Glazovskiy, 1982)

Product	Cn for elements with biosphere Clark 10^{-2}	Cn for elements with biosphere Clark 10^{-3}	Total
Coal	220	1500	1720
Oil	200	20	220
Gas	190	510	700
Mineral fertilizer	50-700	До 1300	50-2000
Foliar feed	40	2400	280
Waste water mud	0	200-3000	250-3000
Manure	10	-	-
Agricultural production	60	150	210
Wood	20	80	100
Oil field waters	10-100	100-700	100-800
Drainage waters	2-5	5-500	2-500

Total noosphere concentration index can be used to compare different manufacturing products according to their geochemical impact on the environment **:**

$$\mathbf{Cn=i\ C_1/Nn_1+ \ldots + C/Nn_j,}$$

where,

C - component content in this product, N_n - Clarks relevant to components in the noosphere (biosphere);

I - number of abnormal elements.

Noosphere concentration indexes demonstrate increasing rate of element content in different products, in comparison to the environment. These indexes are calculated on the basis of their element composition in some products.

Noosphere

NOOSPHERE (noos – mind)

In 1863 geologist Sir Charles Lyell in «Geologic Evidence Of Human Antiquity» and biologist Thomas Henry Huxley in «Humans As Organic Creatures» for the first time attempted to understand humanity as natural geological and biological event in evolutionary series of Nature revolution.

V. I. Vernadsky in 1944 published «Few Words About Noosphere»

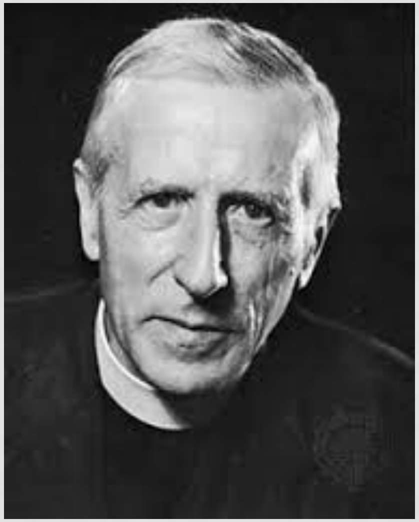
He noted that humanity becomes a powerful geological force moving biosphere to a new evolutionary form – NOOSPHERE.

He considers man as a specific homogeneous part of living matter of biosphere. V. I. Vernadsky views scientific ways and methods as of converting biosphere to natural planetary phenomenon.

In accordance to Vernadsky the formation of the noosphere is a planetary process of establishing the harmonious interaction and relationship between the two most powerful geological forces of the planet - the substance in the biosphere and human beings.

The **noosphere** is the sphere of human thought. The word derives from the Greek νοῦς (nous "mind") and σφαῖρα (sphaira "sphere").
This term was introduced by Pierre Teilhard de Chardin in 1922 in his *Cosmogenesis*.
Another possibility is the first use of the term by Édouard Le Roy (1870–1954), who together with Teilhard was listening to lectures of Vladimir Ivanovich Vernadsky at the Sorbonne.


V. I. Vernadsky
1863-1945)


P. T. de Chardin
(1881-1955)


É. Le Roy
(1870-1954)

Term “noosphere” didn't appear coincidentally. In the 1920’s of the XX century V. Vernadsky discussed the problem of scientific thought with P.T. de Chardin and E. le Roy

They concluded that scientific thought is the biospheric cosmic phenomenon and that its development is associated with the formation of the “noosphere”.

E. le Roy firstly used the term “noosphere”.

P. Teilhard de Chardin, scientist of the Jesuit Order (a male religious congregation of the Catholic Church**), the author of the famous book "The Phenomenon of Man" determined the “noosphere” an ideal spiritual envelope above the biosphere.**

V. Vernadsky turned to this term in the 30’s of the XX c. He emphasized its biogeochemical interpretation. In his understanding the conception of the “Noosphere” includes the idea of conjugate evolutionary development of the biosphere and humanity as sensible biological species.

A peculiarity of the geosphere development at the present stage of geological time consists specifically in this conjugation.

Man is one of the three million biological species.

"Man" and "Humanity" - different categories.

Man – falls off the edge of the earth intravital phenomenon.

Humanity is a historical and cosmic phenomenon.

Humanity is composed of ethnic groups that live and go into oblivion.

Humanity obtains energy and “past humanities” technologies, environmental problems and the next challenges which humanity must successfully or unsuccessfully overcome.

The humanity generation is a new era in the geological history of our planet:

- PSYCHOZOIC ERA (L. de Comte, C. Shuhert)

- Anthroposphere (A.P.Pavlov)

- Noosphere (Vernadsky)

«Nowadays we observe a new geological evolutionary biosphere change and we are entering the Noosphere.... "

(Vernadsky, 1944)

V. I. Vernadsky established a new phenomenon in the geological history of our planet - the transformation of its geological habitus due to the lifetime period of one human generation.

The noosphere concept by Vernadsky introduces the idea that the historical human development is the biogeochemical history of the living biosphere matter.

Rational biological species create and increase new energy form embracing normal biogeochemical energy and affect new migration forms of chemical elements being biogeochemical Planet agents.

This new form of energy can be called as ".. the energy of human culture or cultural biogeochemical energy .." It is this energy that creates the noosphere.

According to many philosophers and scientists the destiny of the Humanity is to create a newly-organized biosphere.

V. I. Vernadsky, analyzing the role of human mind and scientific thought, came to the following conclusions:

- The process of scientific creativity is the force by which a person changes the biosphere in which he lives.
- The manifestation of biosphere changes is an inevitable phenomenon accompanying scientific thought.
- Thy biosphere change is independent of the human will. It is spontaneous as a natural process.
- As the environment of human life is an organized sphere of the planet - i. e. biosphere, as a new impact factor - scientific work of humanity - is a natural process of the transformation from the biosphere to a new phase - the noosphere.

- In the present historical period, the “Laws of Nature“ are more evident and this can be seen in such areas as geochemistry and biogeochemistry which mathematically highlight the most important processes.

- The fact that the biosphere will inevitably transfer into the noosphere where human development playes the dominant role was coined as Vernadsky NOOSPHERE LAW.

http://intelligentchristianfaith.files.wordpress.com/2013/05/rainbow-tree.jpg

M.M. Kamshilov (1974) considering the biosphere evolution and its transition to the noosphere mentioned:

- Biosphere (B) emerged in the big abiotic matter cycle (A);
- as life develops, the biosphere (B) expands;
- in the biosphere (B) the human society (H) emerges;
- human community begins to absorb matter and energy not only through the biosphere but also directly from the abiotic environment (T);
- the biosphere which has transferred into the noosphere (H) is developing under control of rational human activities (noogenesis);
- life developing through noogenesis assimilates matter, energy and the potential of inorganic nature and extends beyond the Earth.

- **Vladimir Putin said at the business summit of the Asia-Pacific Economic Cooperation in the Palace of the Sultan Brunei in November 2000:**

- ***“In the early twentieth century Vladimir Vernadsky created the doctrine of uniting humanity space - the noosphere.***

It combines the interests of countries and nations, nature, society, scientific knowledge and public policy.

Today the concept of sustainable development is based on this concept».

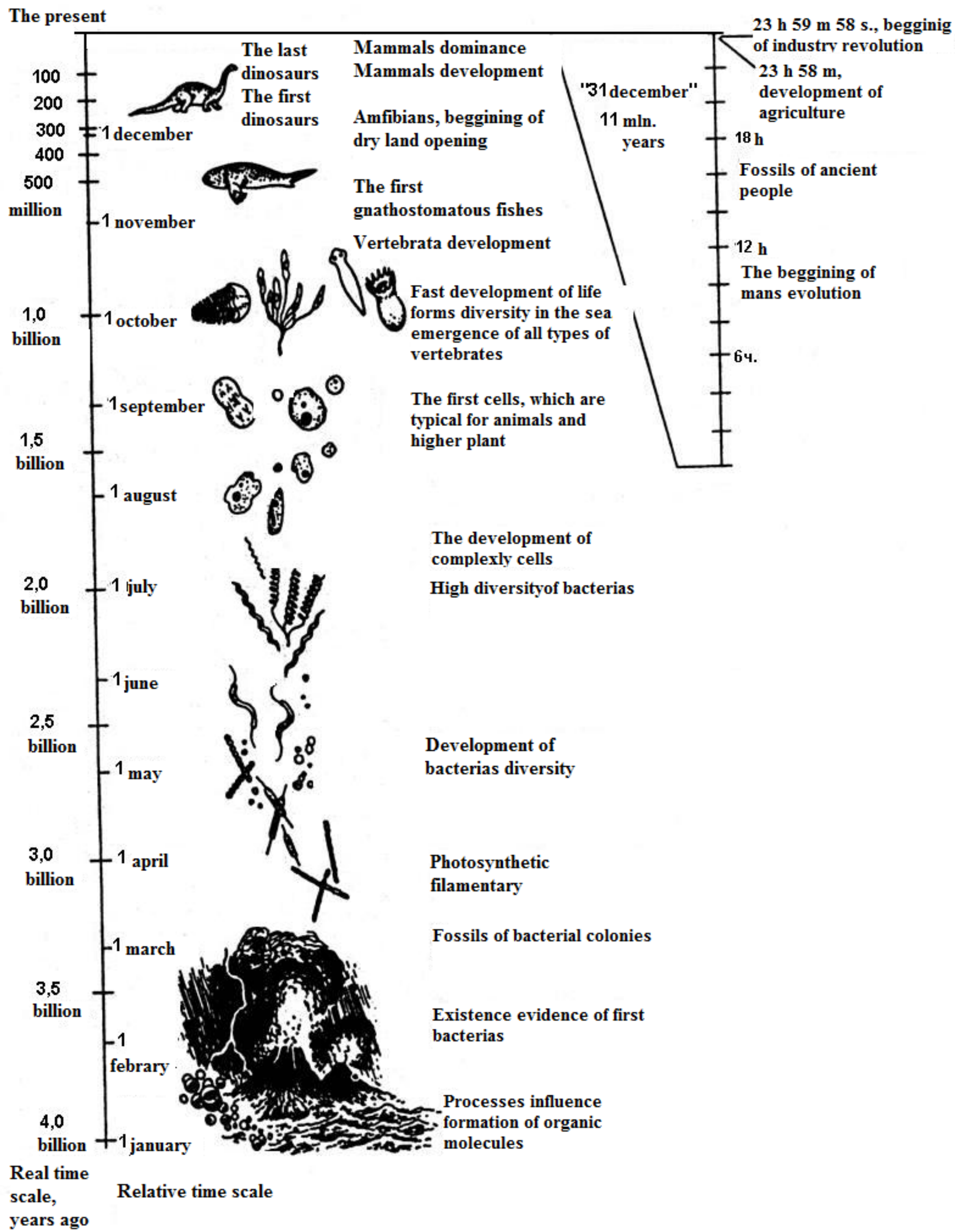
https://www.lynascorp.com/SiteCollectionImages/Sustainable_Development.jpg

V. I. Vernadsky pointed out that human beings have almost forgotten that all humanity are inseparably linked with the biosphere, one of the geospheres of the Earth, in which they live.

"They are geologically consistently involved with its material - energy structure. Spontaneously man is inseparable from it"

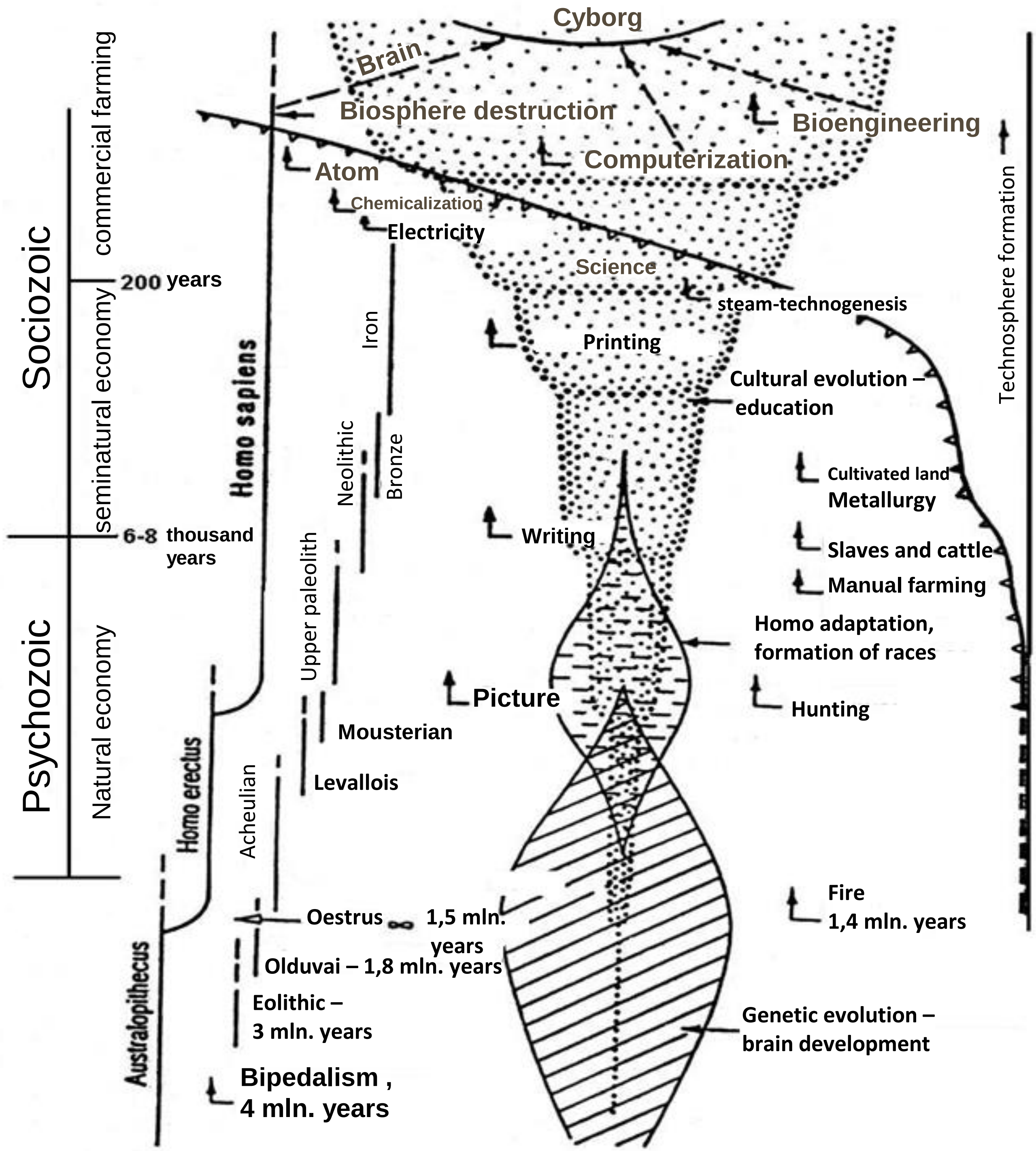
(Vernadsky, 1988)

- V. I. Vernadsky predicted that possible application of the scientific thought usage, scientific could discoveries “evil for evil and be harmful."
- He was against the overusage of scientific discoveries. V. I. Vernadsky did not expect that the transformation of humanity into a powerful geological environment would result in the ecological crisis of civilization and that scientific thought as a planetary phenomenon may be the most destructive antibiotic force.
- One of the most striking examples of this thesis is the fact that humanity uses the phenomenon of radioactivity.



Comparison of the geologic time scale with one year gives visualization of the relative duration of the different stages in the evolution.

Periodization of the society history - the transition from genetic evolution (biogenesis) to the cultural (noogenesis) according to V.A.Zubukov (1990).



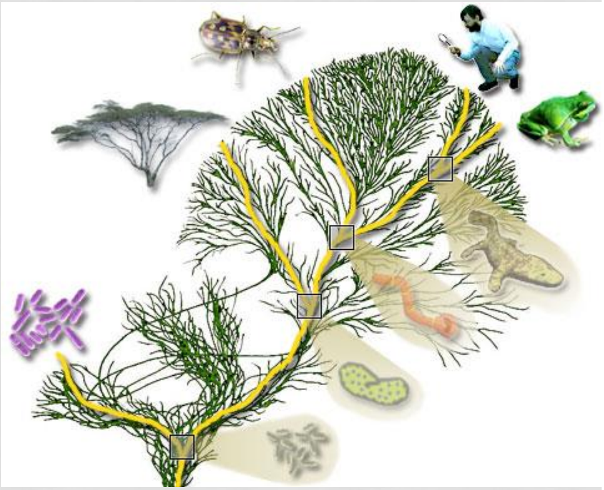
Newborn noosphere in its main development is characterized by the following features:

•Increasing amount of mechanically extracted material of the lithosphere (the mineral deposits development growth). It exceeded more than 100 million t per year in 90's of 20th century, which is 4 times higher than the mass of the material carried out by river flows into the ocean during land denudation.

•Photosynthesis active mass consumption of past geological eras mainly for energetic purposes. The chemical balance in the biosphere shifted to the direction opposite the global photosynthesis process, resulting in to carbon dioxide concentration increase and free oxygen reduction in the biosphere.

•The noosphere processes result in the Earth's dispersal energy. It was specific forbiosphere condition before human existence. Energetic problem occurred.

•A great mass of elements entering the noosphere, which have not existed in the biosphere. This is the so called biosphere metallization.



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•The development of nuclear technology and nuclear energy furthered the creation of new transuranium chemical elements specific to the noosphere. Obtaining the “first energy” through the division of heavy nucleus. The production of thermo-nuclear energy through light nucleus fission.

•Due to the enormous scientific progress the concept “noosphere” has spread beyond the concept “biosphere”; and based on modern space programs a new science area was developed - space exploration.

•The Earth transgressed to a new qualitative state with the noosphere development. If the biosphere is the sphere of the Earth, the noosphere is a sphere of the solar system.

Geochemical clarks of noosphere (biosphere)

Elements	%	Elements	%	Elements	%	Elements	%	Elements	%
O	63,2	Zn	4,6			10^{-6}		Nb	1,9
Si	16,5	Ba	3,6			In	6,4	10^{-18}	
Al	6,1	Ce	3,2	Dy	3,0	Ag	5,0	Pm	6,9
H	4,5	Br	2,6	Hf	2,5	Rb	3,3	10^{-19}	
Fe	2,2	Co	2,2	U	1,9	Os	3,2	Rn	1,1
Ca	1,6	Y	2,05	Ta	1,9	He	2,0	10^{-21}	
K	1,6	Ag	1,95	Yb	1,9	Ne	1,96	Fr	7,6
Na	1,9	Li	1,9	Fr	1,7	10^{-7}		At	2,5
10^{-1}		Ga	1,7	W	1,3	Pb	8,3		
Mg	9,0	Nd	1,6	Ge	1,1	Bi	6,4		
Cl	6,9	Nb	1,3	Mo	1,1	Rh	6,4		
C	4,4	Zr	1,2	Be	1,0	Te	6,4		
Ti	2,6	Pb	1,2	10^{-5}		Kr	4,1		
S	1,7	La	1,2	Tl	7,9	Ir	3,8		
N	1,2	Ni	1,0	Ho	7,6	10^{-8}			
10^{-2}		10^{-4}		En	6,4	Au	6,9		
P	5,0	Th	7,6	Tb	6,4	Xe	5,4		
Mn	4,4	Sc	7,0	I	5,4	Re	4,7		
F	3,5	Cs	5,9	Lu	4,5	10^{-10}			
Sr	0,4	Sn	4,9	Se	2,8	Ac	1,9		
10^{-3}				Sb	2,5	Ra	1,3		
Rb	9.6	Gd	4,9	Hg	1,8	10^{-14}			
V	7	Pr	3,85	Cd	1,6	Po	1,3		
B	5	As	3,05	Tn	6	10^{-16}			
Cr	5			Pt	1,3	Pu	1,3		

Basic characteristics aspects of geochemical life processes (Fersmann):

- ❖All elements of the Mendeleev table involved practically in all biochemical processes.
- ❖Most biogeochemical processes are enclosed in cycles of different nature and different scale.
- ❖The main well-defined elements: C, H, N, R, Na, Ca, S, P, Mg, F, Cl, AI - typical biogenic elements, whereas C, O, Ca, S, Mg, Fe are even-numbered ones in the biochemical processes.
- ❖The role of biochemical factors in surface supergene processes is immense and probably the majority of atoms in geosphere shells at this or that migration were connected with biochemical systems and their bioliths.
- ❖All biochemical processes are subjected to the basic physico-chemical laws which in its turn and are associated with complex atom groups with mobile colloidal behavior and are energetically dependent on the exothermal processes within the combustion conditions of living cells.

- ❖As life processes are very sensitive to any temperature, pressure and other changes, the biochemical complexes create pronounced geochemical, climatic and bathymetric zones in the hydrosphere and lithosphere.
- ❖Important moment is the biomechanical processes dependence on the pH and the oxidation-reduction potential and these two factors have enormous influence on the supergene processes.
- ❖The effect of organized solvents affects not only the biochemical complexes connected with living cells, but also some features of living matter influenced migration in physiological waste material and secretion activity.
- ❖Geochemical life form structures of individual elements transformed throughout geological periods. This evidence proved the Samoylov concept of organism paleophysiology. It especially evinced during the second half of 20-th century when humans started to develop nuclear energy. Isotopic-chemical biota structure changed.
- ❖The total energetic effect of living matter activity is significant. It can not be calculated, so, energetic base of living matter is the sun energy.

HUMAN PRODUCES

1. Flaring of C, H, S to CO_2, H_2O, SO_3.
2. Melting from oxygenized and sulfur metal compounds (Fe, Cu, Al, Zn, Pb, etc.).
3. The transportation development construction or road materials.
4. Industrial application of rare and dispersed elements.
5. Chemical processing of natural salts (soluble and with big clarks).

- ***First process - reactions decreasing the free energy and forming stable compounds from a large amount of heat, light, and chemical energy.***
- ***Second process – formation of unstable but important metal groups.***
- ***Third process – formation of the most chemically, thermally and mechanically resistant materials.***
- ***As determined by the analysis of natural geochemical processes, resistance to melting, abrasion or dissolution in such elements as Ca, Mg, Fe, O, Si, partially S.***

According to the Clarke curves and geochemical features of Mendeleev periodic Table, these are 3 basic element groups of human industrial activities:

1 – Metals of metallic field;

2 - Stable and thermally and mechanically resistant elements normal field;

3 – Unstable and odd rare elements;

- Process amplitudes in the technogenesis sphere are significantly high, but not one cosmic system includes the contradictory reactions of the entropy law.

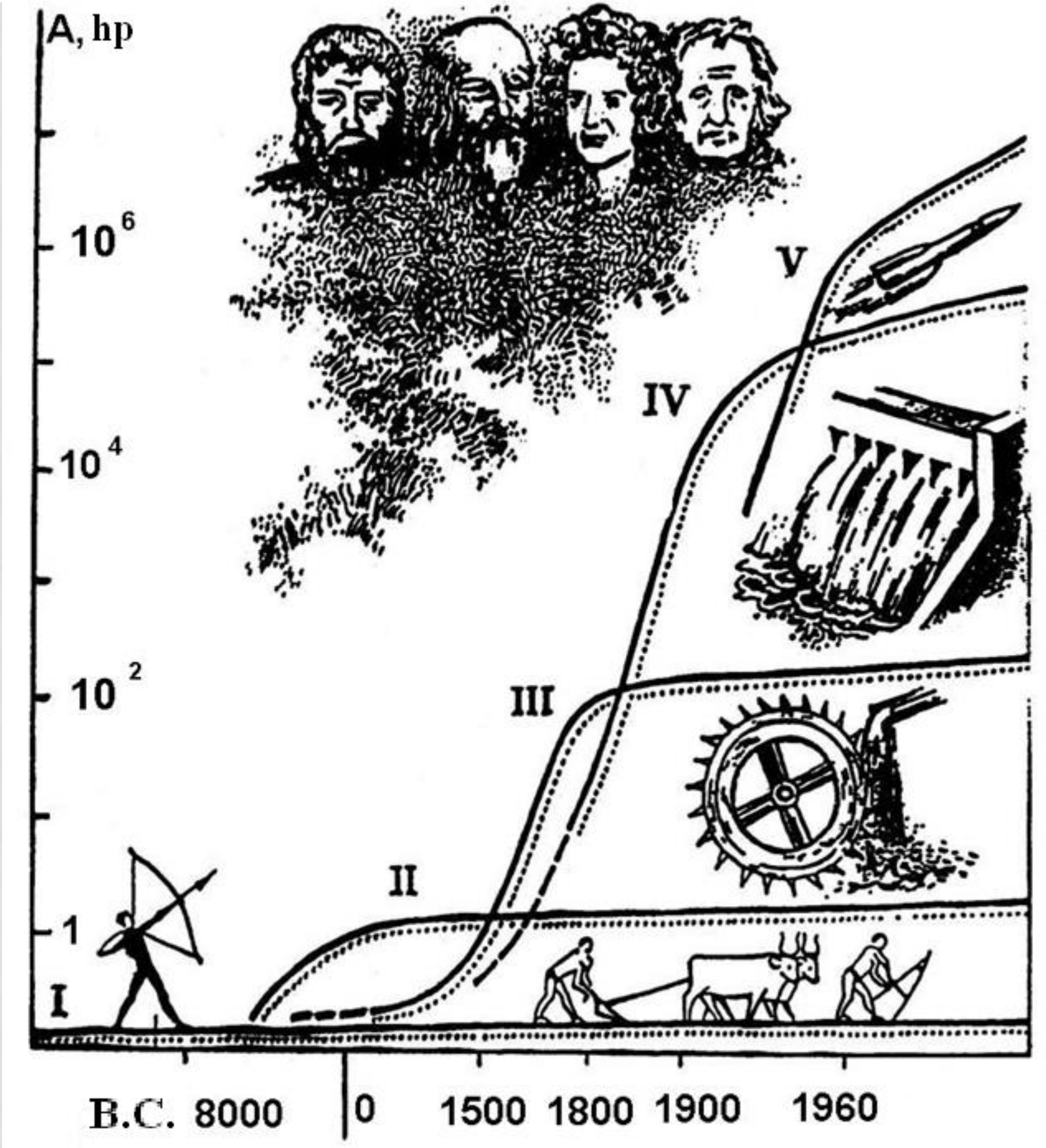
Basic features of geochemical human activity (Fersmann):

- *Geochemical activity is comparable to other natural processes in the Earth's crust.*
- *This activity is based on metallurgical and chemical processes resulting in the accumulation of substances with energy reserves larger than those of the natural bodies.*
- *By creating these systems humans direct his activities against natural geochemical reactions.*
- *Geochemistry of human activity is subjected to Clark's laws, on the one hand, and Mendeleev periodic table laws, on the other hand.*

- *Man gradually embraces all Earth crust elements and uses them in all industrial spheres.*

- *Geochemical human activities are not limited to the processing of the basic crustal elements.*

- *Human activity is regulated by the laws of nature and geochemistry has an impact on the latter.*



A, hp
10^6
10^4
10^2
1
I
II
III
IV
V
B.C. 8000
0
1500
1800
1900
1960