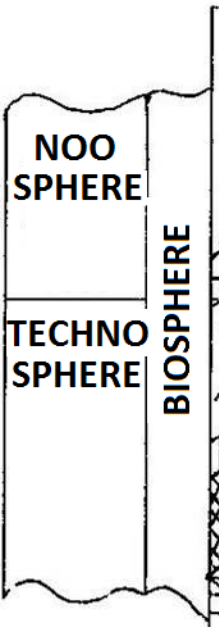
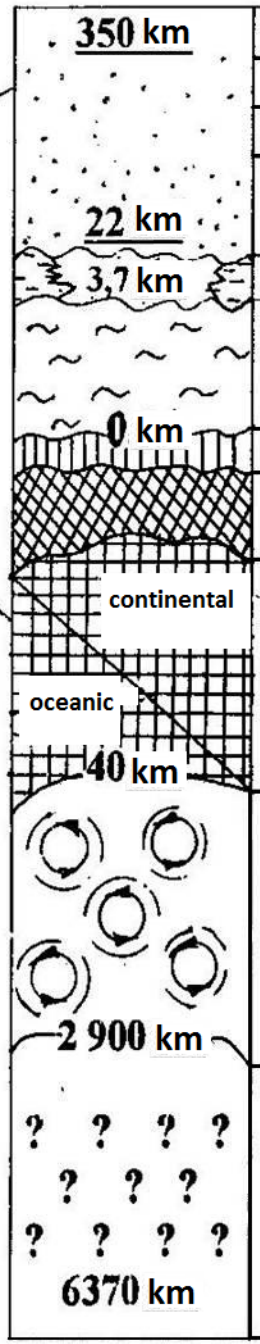

Lithosphere

Geospheres of the Earth





Exosphere Mesosphere Stratosphere Troposphere	Ionosphere		***Atmosphere*** **(atmos - vapor)**	He H O_3 N O_2 Ar CO_2 Ne
Ice (Icesphere?) Surface and underground waters of continents and oceans			***Hydrosphere*** **(hydro - water)**	H(H_2O) O Cl Na
Global Ocean sediment floor Soil (Pedosphere) Crustal weathering , zone of oxidation Hard silicate rocksof different origin (magmatic, metamorphic, sedimentary)			***Lithosphere*** **(litos - rock)** Relatively hard, rigid outer shell of the Earth (Earth crust).	O Si Al P K Na Ca Mg Ti Fe Ni
Mantle **(mantle - cover)**	**Upper**		***Asthenosphere*** **(asthenes - weak)** Layer with low hardness density, velocity. Deep geologically active layer.	
	Lower			
Earth core	**Outer**			Fe ? Ni ? C (?) H (?) U (?)
	Transition zone			
	Inner			

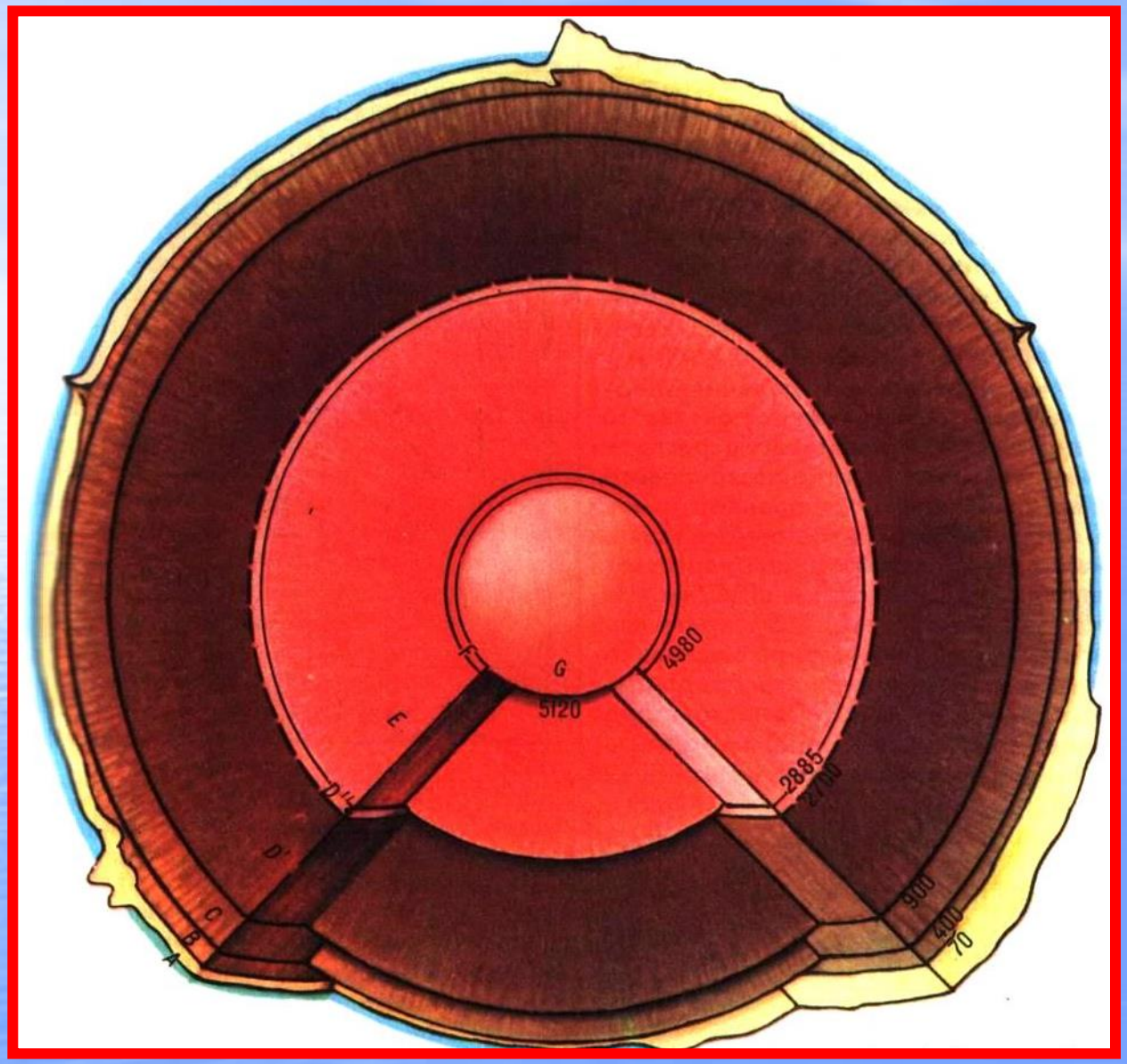
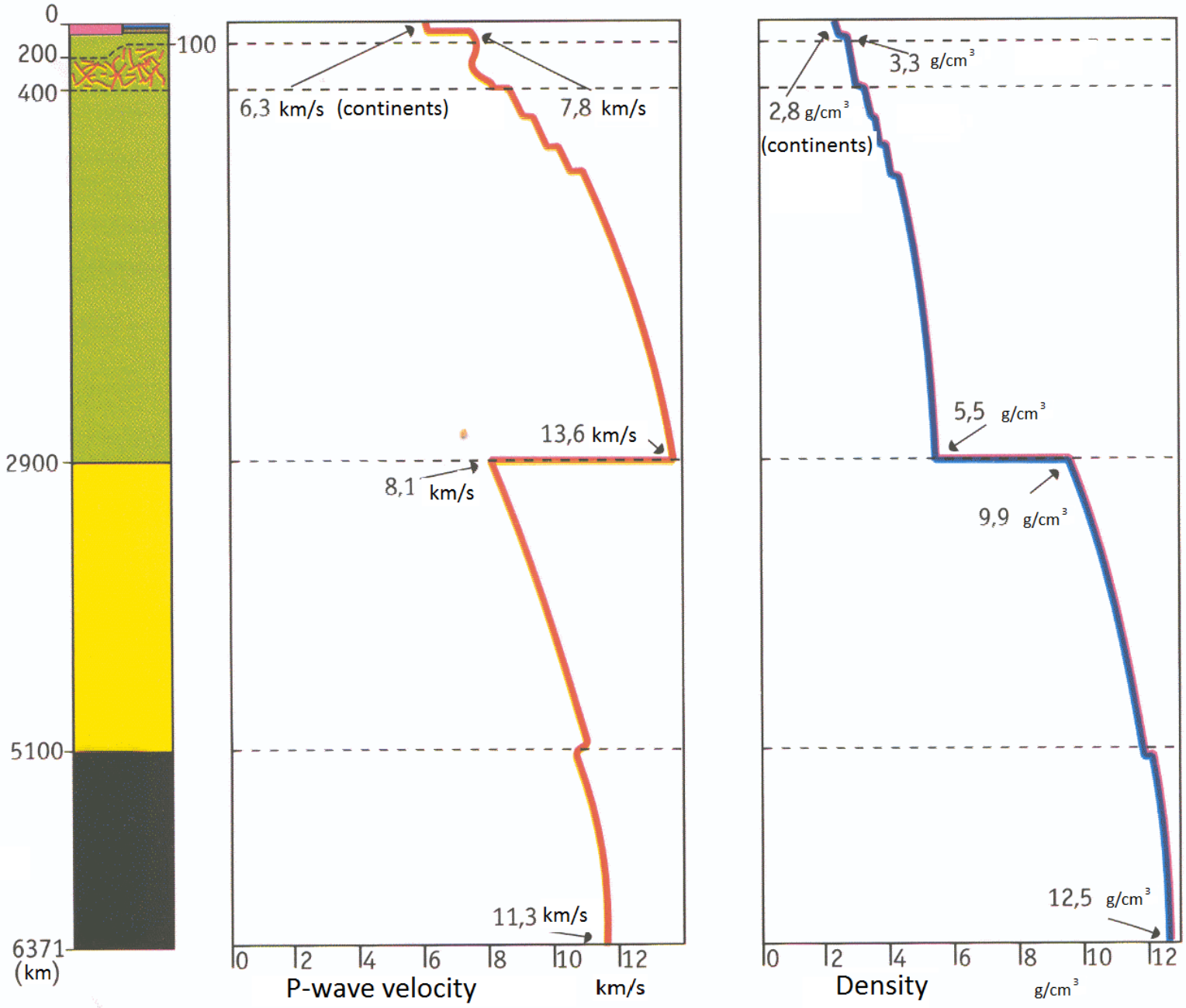


Fig.1
Earth structure

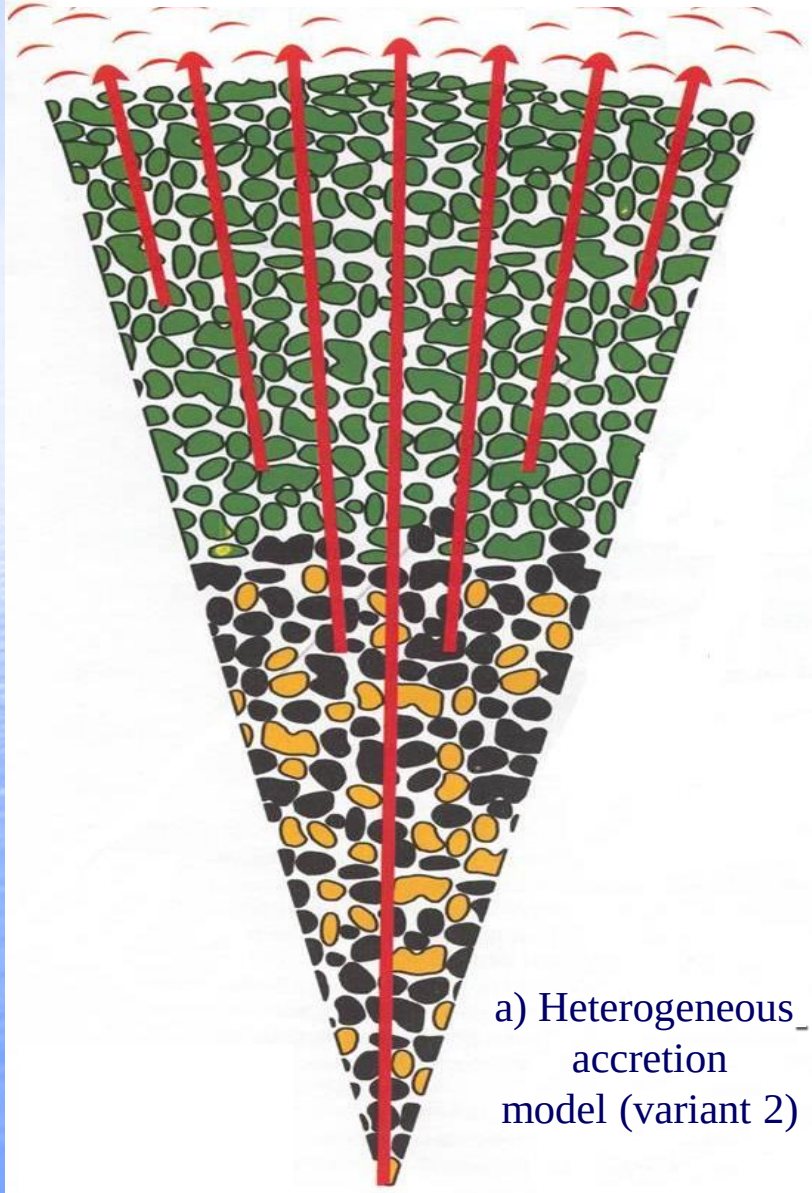

0
200
400
2900
5100
6371
(km)
100
6,3 km/s (continents)
7,8 km/s
13,6 km/s
8,1 km/s
11,3 km/s
0
2
4
6
8
10
12
P-wave velocity
km/s
3,3 g/cm³
2,8 g/cm³
(continents)
5,5 g/cm³
9,9 g/cm³
12,5 g/cm³
0
2
4
6
8
10
12
Density
g/cm³

Inner Earth structure (Voronov, 1968)

Index	Layer		Depth interval	Density (g/sm^3)	Probable		Part of total mass (%)
					Temperature, ^oC	Pressure (mln.atm.)*	
A	Earth crust		0-40	2.7-2.9	1000-1100	0.01	0.8
B	Mantle (atmosphere)	Upper	40-400	3.3-3.6	1499-1700	0.14	10.4
C			400-960	3.6-4.7			16.4
D'		Lower	960-2740	4.7-5.6	1600-2400	0.39	
D''			2740-2900	5.6-5.7			41.0
E	Inner core		2900-4990	9.4-11.5	2200-4700	1.37	
F	Transition zone		4990-5150	11.5-14.2(?)			31.5
G	Outer core		5150-6371	16.8(?)-17.2(?)	5000	3.3-3.6	

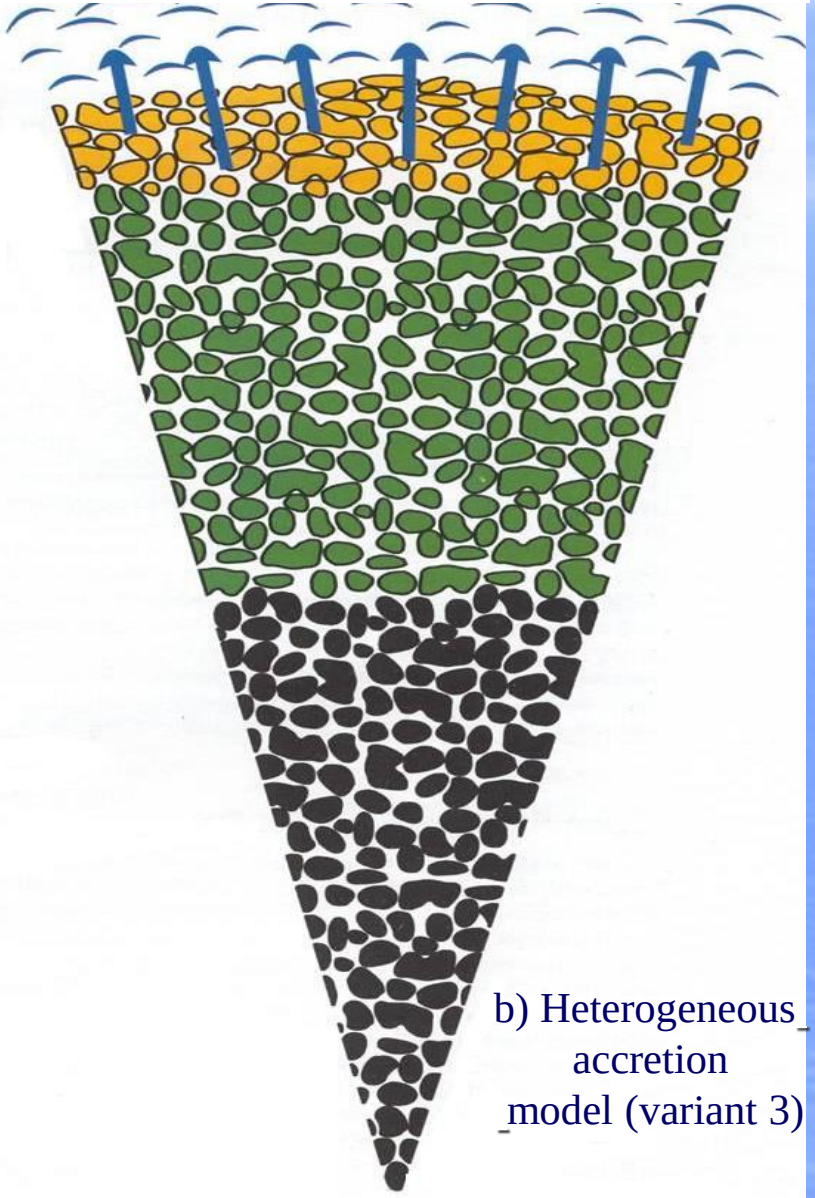
- According to statistics of K.E. Bullen [1961], V.A.Magnitskiy [1965] and I.Verhugen [1958].
- 1 atm = 10^5 Pa

Sharp reducing primary atmosphere, consisting of H_2, CH_3, NH_4

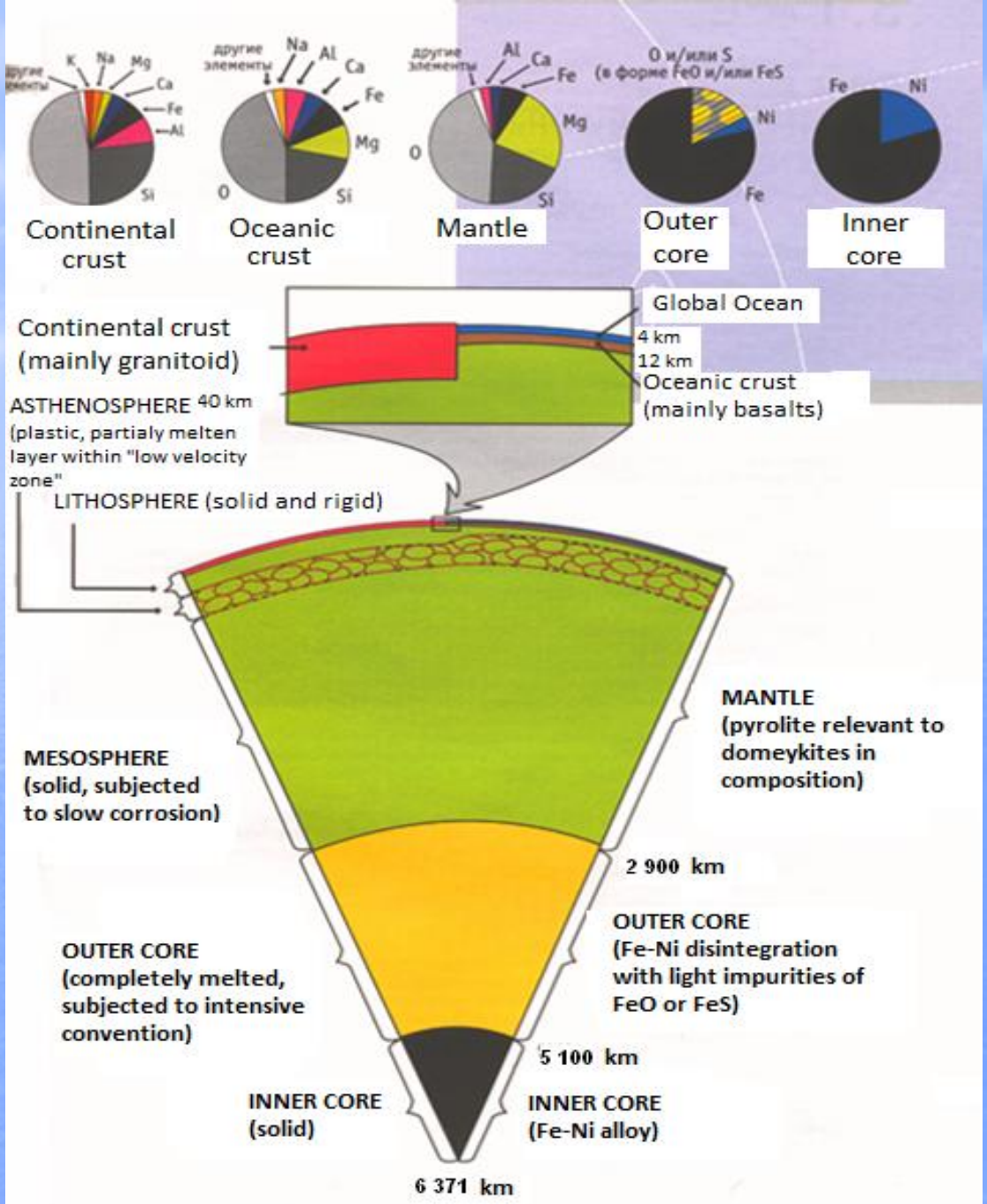


a) Heterogeneous accretion model (variant 2)

Neutral primary atmosphere with predominating H_2O, CO, N_2, CO_2



b) Heterogeneous accretion model (variant 3)


Continental crust
Oceanic crust
Mantle
Outer core
Inner core
Global Ocean
4 km
12 km
Continental crust (mainly granitoid)
Oceanic crust (mainly basalts)
ASTHENOSPHERE 40 km (plastic, partialy melten layer within "low velocity zone"
LITHOSPHERE (solid and rigid)
MANTLE (pyrolite relevant to domeykites in composition)
MESOSPHERE (solid, subjected to slow corrosion)
2 900 km
OUTER CORE (Fe-Ni disintegration with light impurities of FeO or FeS)
OUTER CORE (completely melted, subjected to intensive convention)
5 100 km
INNER CORE (solid)
INNER CORE (Fe-Ni alloy)
6 371 km

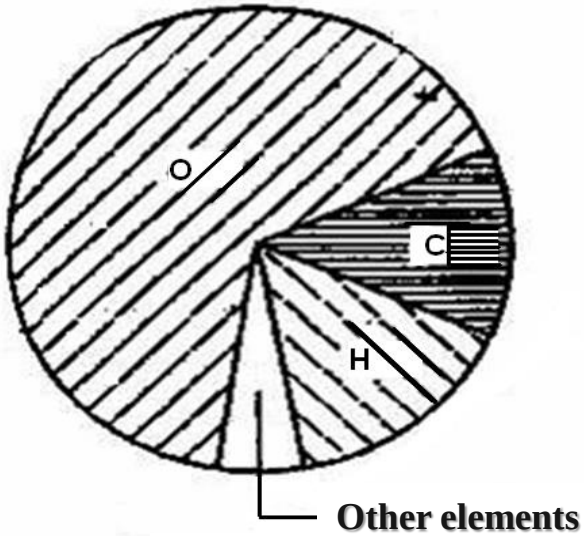
Element composition of the Earth

Chemical element	Weight percentage	Chemical element	Weight percentage
Iron	34.63	Sodium	0.57
Oxygen	29.53	Chromium	0.26
Silicon	15.20	Manganese	0.22
Magnesium	12.70	Cobalt	0.13
Nickel	2.39	Phosphorus	0.10
Sulfur	1.93	Potassium	0.07
Calcium	1.13	Titanium	0.5
Aluminum	1.09		

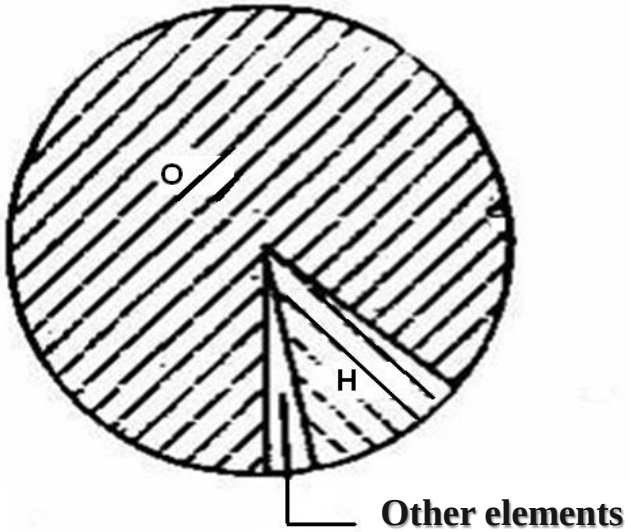
Average content of some chemical elements in the Earth crust, soil and living organisms (weight %, dated 1968)

Chemical elements	The Earth crust (sedimentary rocks)	Soil	Living organisms (plants)
B	$1*10^{-2}$	$1*10^{-3}$	$1*10^{-4}$
C	1,0	2,0	18,0
N	$6*10^{-2}$	$1*10^{-1}$	$3*10^{-1}$
O	52,8	49,0	70
F	$5*10^{-2}$	$2*10^{-2}$	$1*10^{-5}$
Na	0,66	0,63	$2*10^{-2}$
Mg	1,34	0,63	$7*10^{-2}$
Al	10,45	7,1	$2*10^{-2}$
Si	23,8	33,0	$1,5*10^{-1}$
P	$7*10^{-2}$	$8*10^{-2}$	$7*10^{-2}$
S	$3*10^{-1}$	$8*10^{-2}$	$5*10^{-2}$
Cl	$1,6*10^{-2}$	$1*10^{-2}$	10^{-2}
K	2,28	1,36	$3*10^{-1}$
Ca	2,53	1,37	$3*10^{-1}$
Ti	0,45	$4,6*10^{-1}$	$1*10^{-4}$
Mn	$6,7*10^{-2}$	$8*10^{-2}$	$1*10^{-3}$
Fe	3,3	3,8	$2*10^{-2}$
Cu	$5,7*10^{-3}$	$2*10^{-3}$	$2*10^{-4}$
Sr	$4,5*10^{-2}$	$3*10^{-2}$	$4*10^{-4}$
Zr	$2*10^{-2}$	$3*10^{-2}$	10^{-4}
I	$1*10^{-4}$	$5*10^{-4}$	$1*10^{-5}$
Ba	$8*10^{-2}$	$5*10^{-2}$	10^{-4}
U	$3*10^{-4}$	$5*10^{-5}$	$5*10^{-7}$

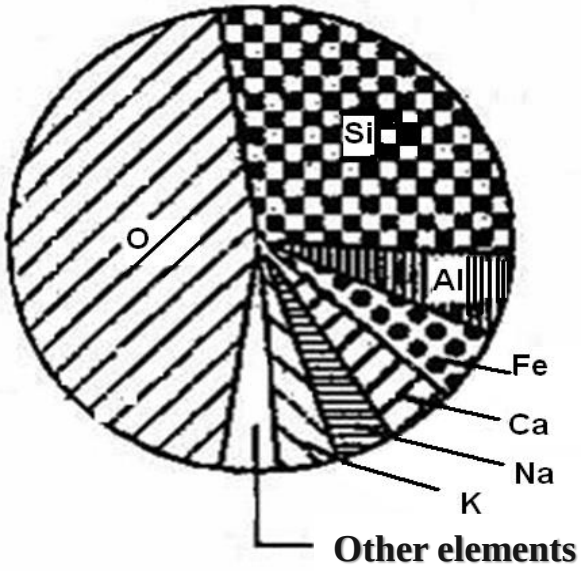
1. **Living substance**



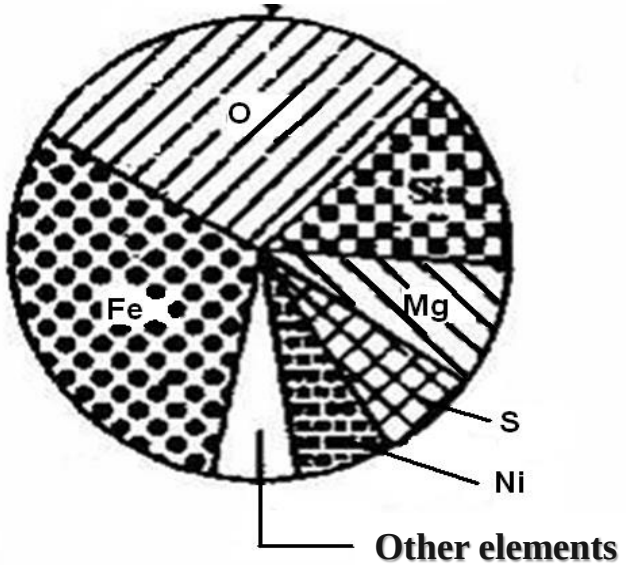
2. **Hydrosphere**

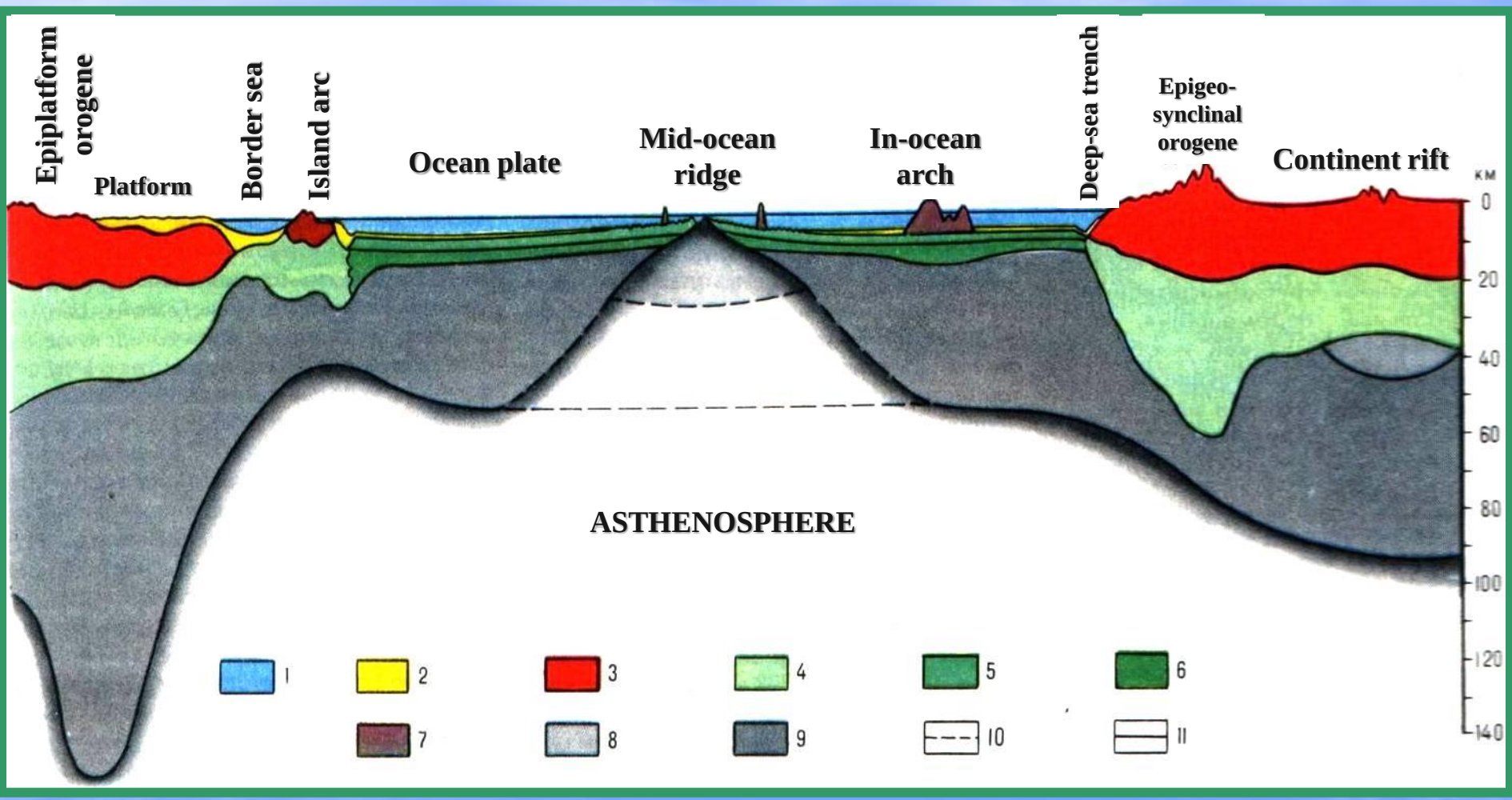


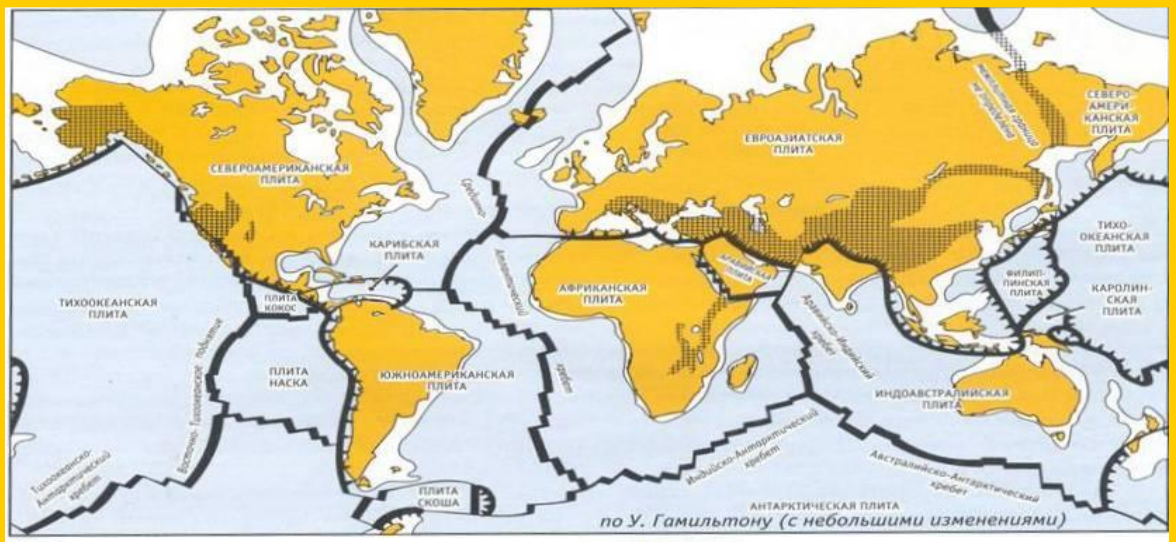
3. **Lithosphere**



4. **The Earth**

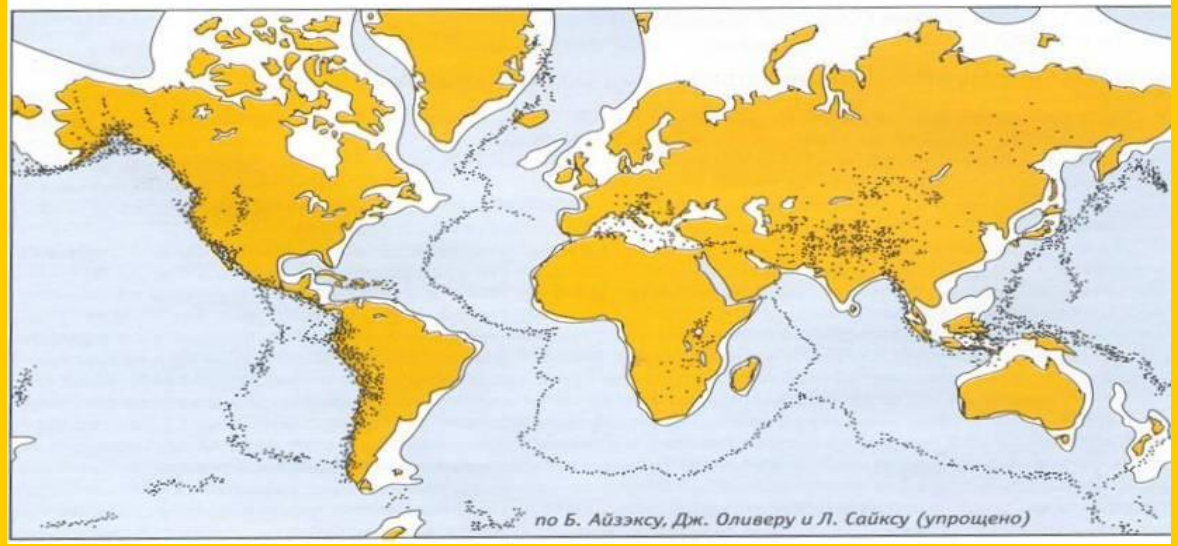



Epiplatform orogene
Platform
Border sea
Island arc
Ocean plate
Mid-ocean ridge
In-ocean arch
Deep-sea trench
Epigeo-synclinal orogene
Continent rift
KM
0
20
40
60
80
100
120
140
ASTHENOSPHERE
1
2
3
4
5
6
7
8
9
10
11



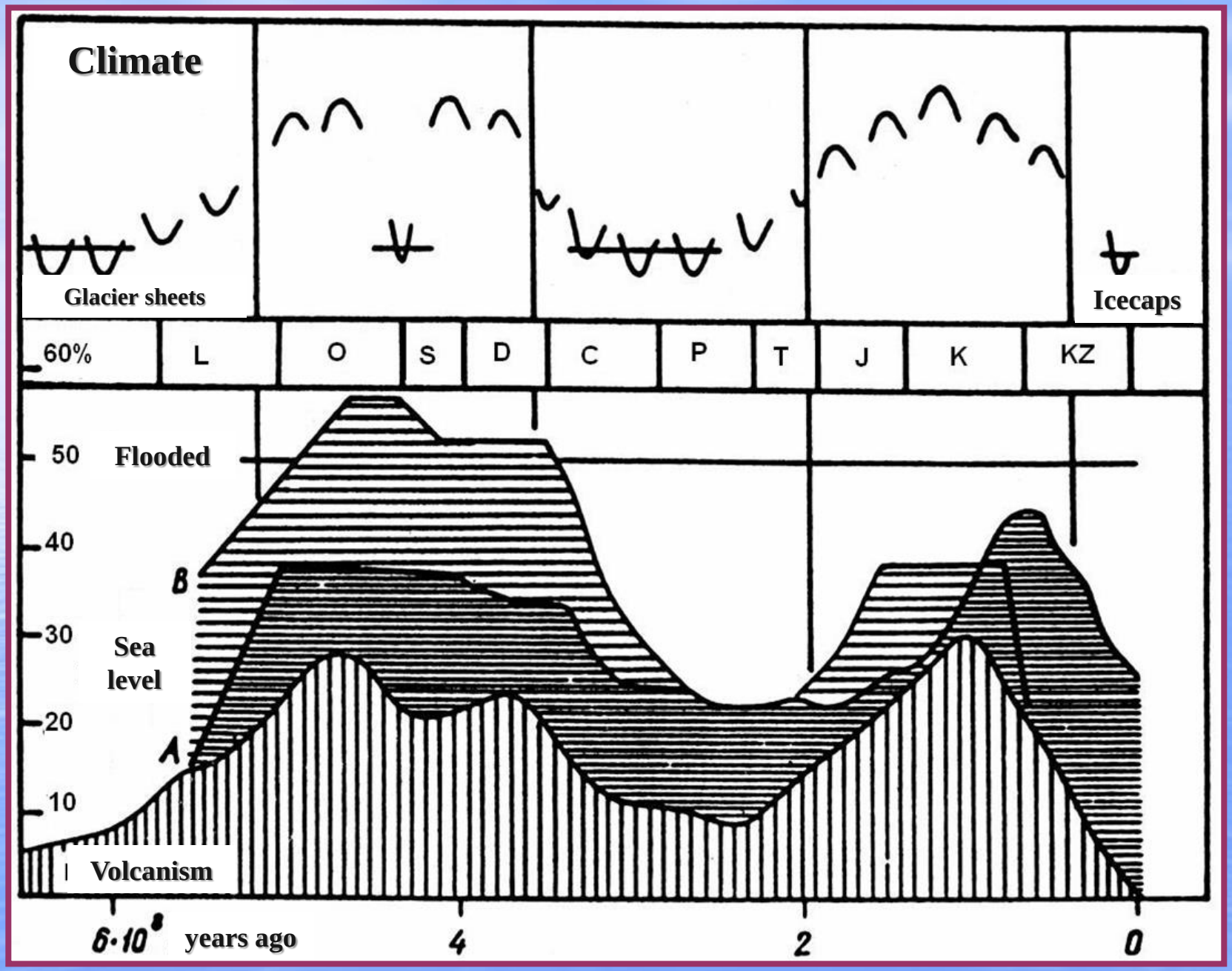
- Spreading zones (mid-ocean ridges);
- Intensive breakage zones in continental crust;
- Subduction zones (deep-sea trenches);
- Zones of continents collision;
- Transform boundary

а) б) -Continental crust (a-land; b- shelf);
- Ocean crust;

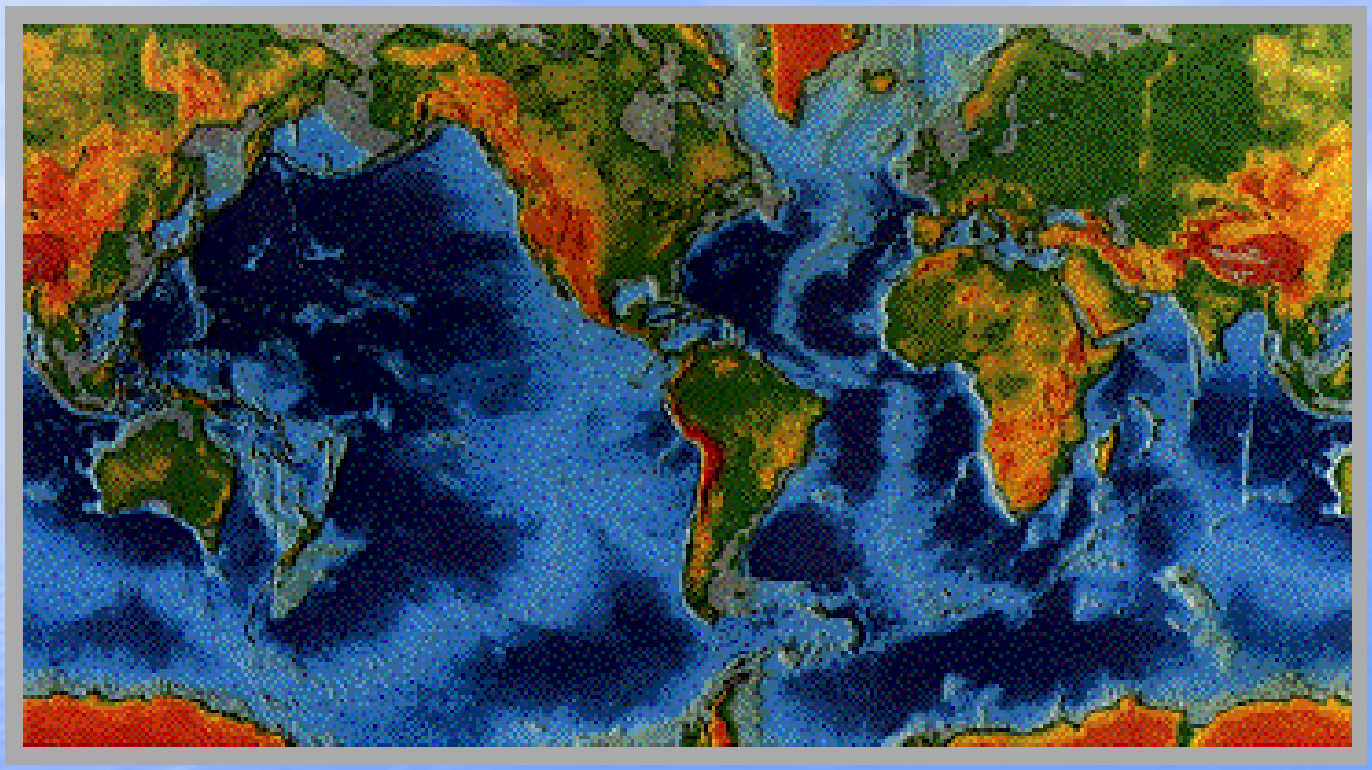


MAP - EARTHQUAKE EPICENTER DISTRIBUTION

This map shows that earthquake epicenters (dots) are distributed on the Earth surface nonuniformly. Usually they range in definite lines, which mark plate boundaries. Seismic activity is significantly higher in subduction zones than in spreading zones.


Climate
Glacier sheets
Icecaps
60%
L
O
S
D
C
P
T
J
K
KZ
50
40
30
20
10
Flooded
Sea level
B
A
Volcanism
6·10⁸
years ago
4
2
0

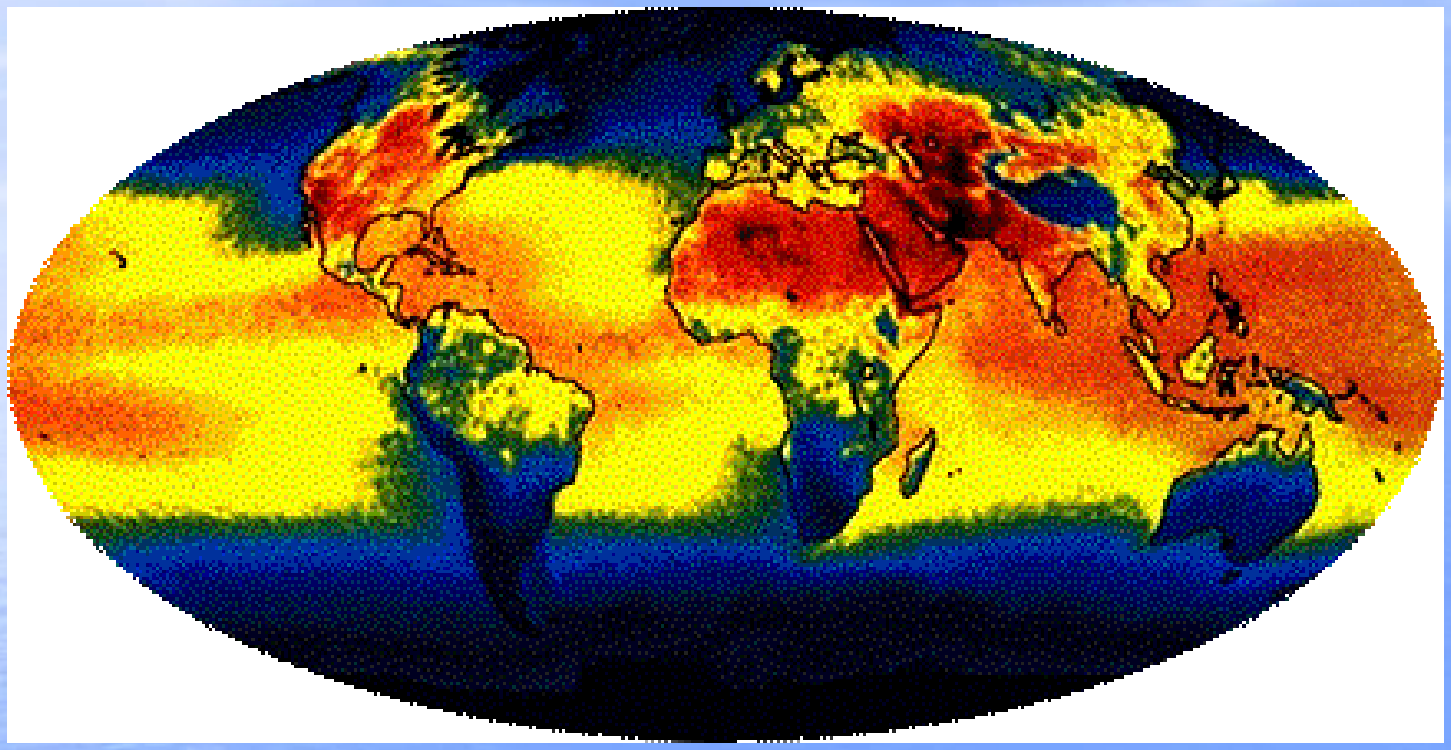
Topography



Different color hues and color density depends on the land elevation and depth. Colors indicate the depth according to the following:

- dark blue - deepest points;
- bright red - highest points;

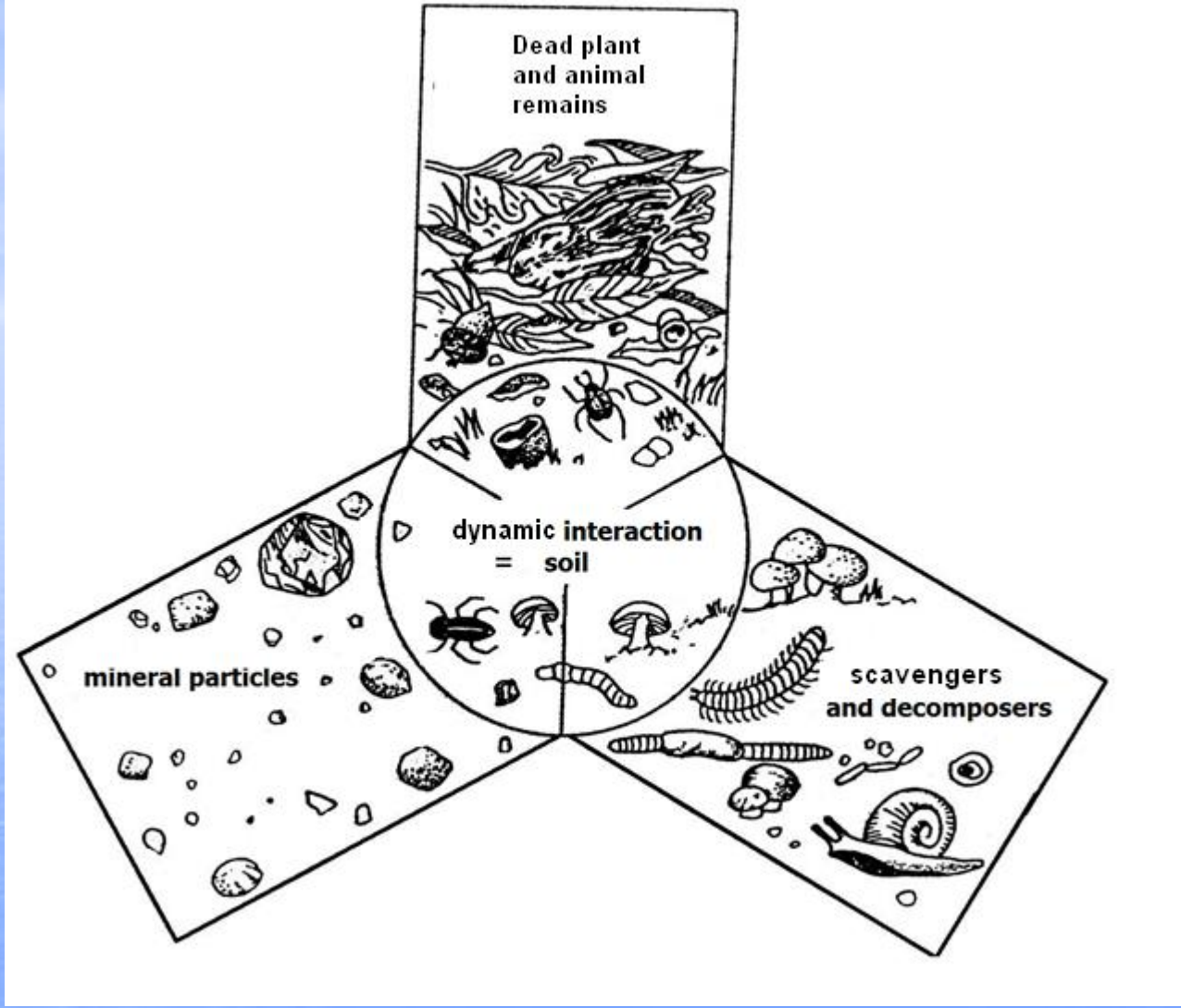
Surface Temperatures



The highest temperature

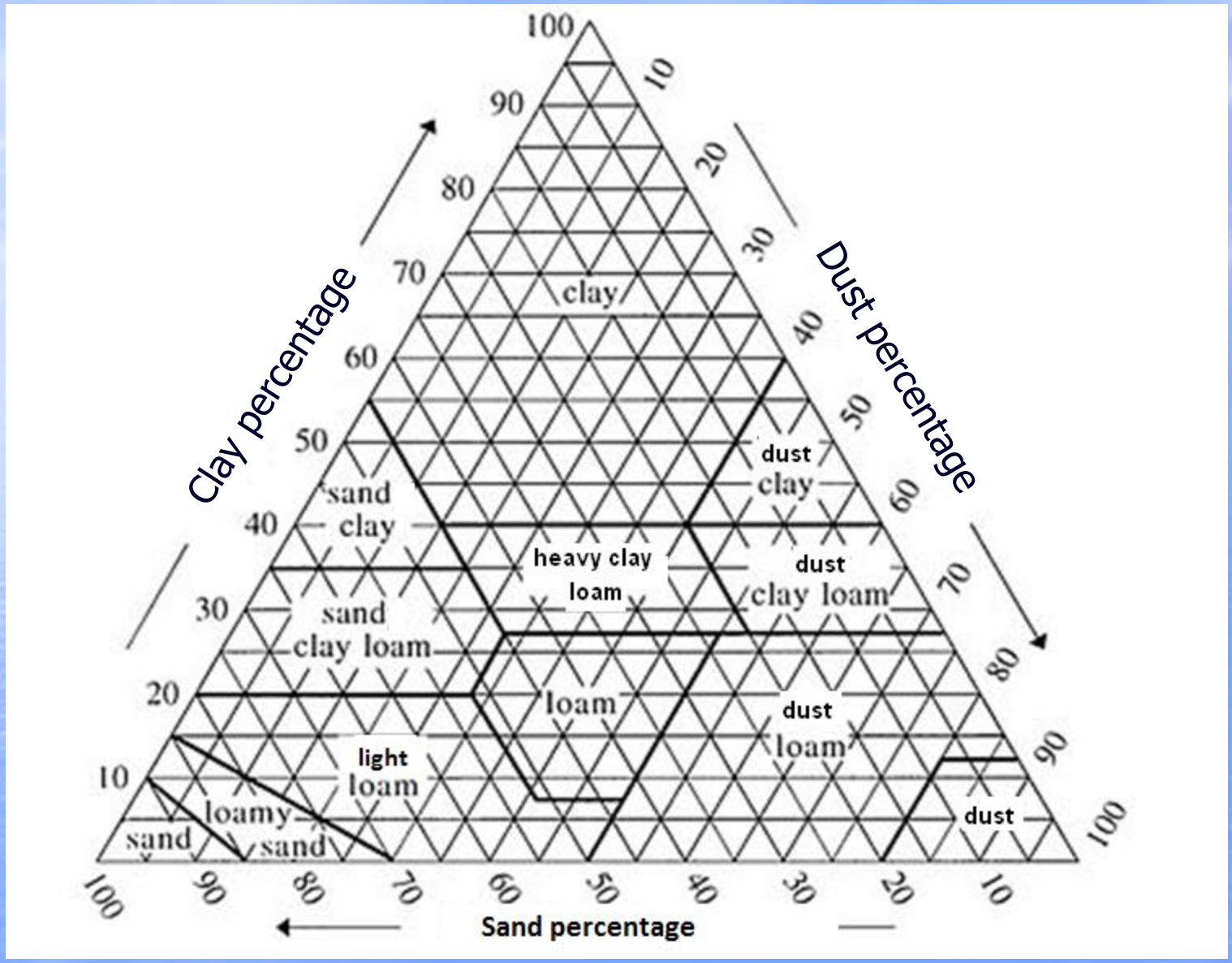
The lowest temperature

(June, 1988)



Fertile soil is the result of the dynamic interaction between the mineral particles, detritus, detritus feeder and decomposers. The lack of at least one of the three components can cause harmful consequences for soil.

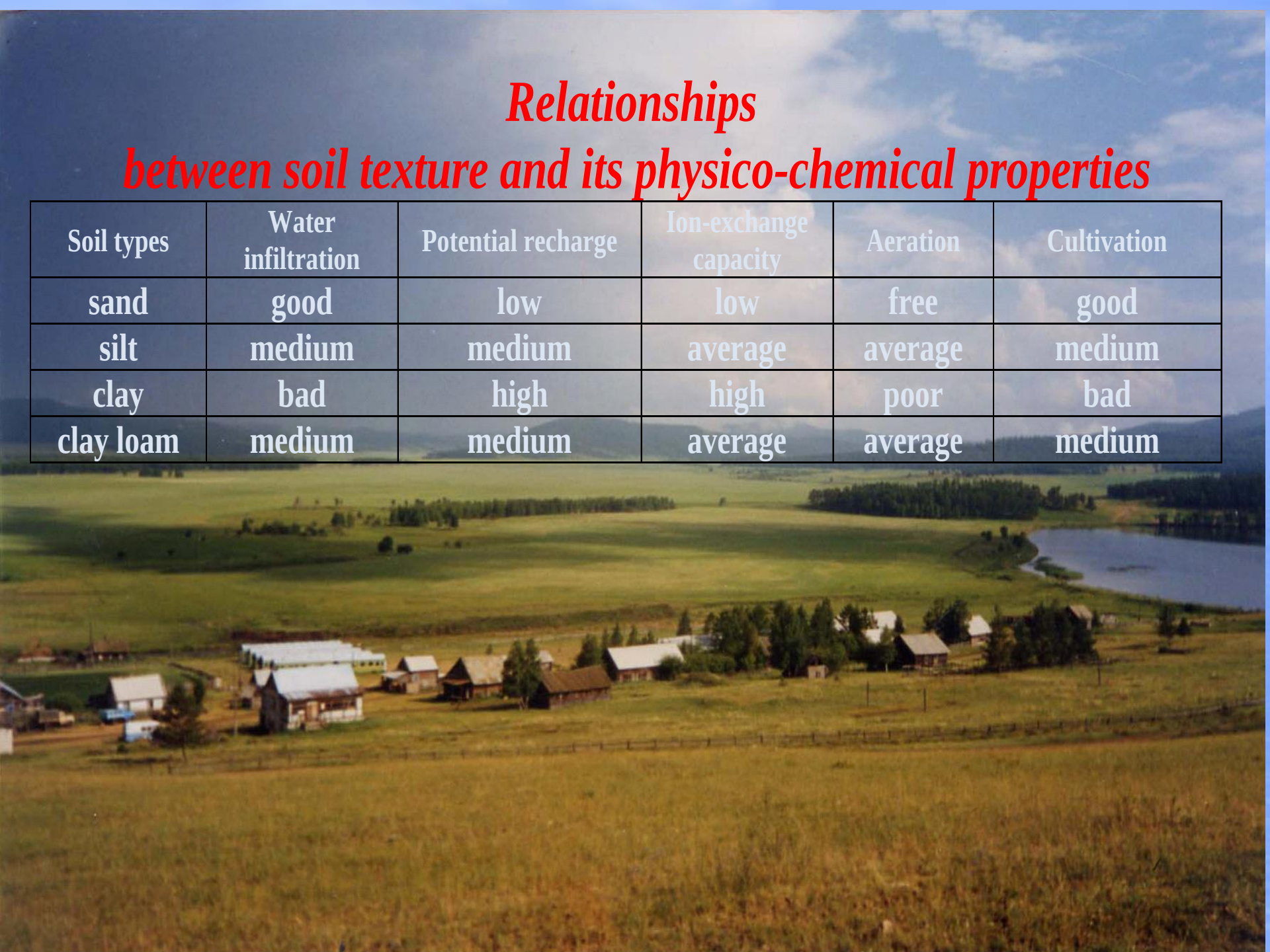
(Nebel, 1993)

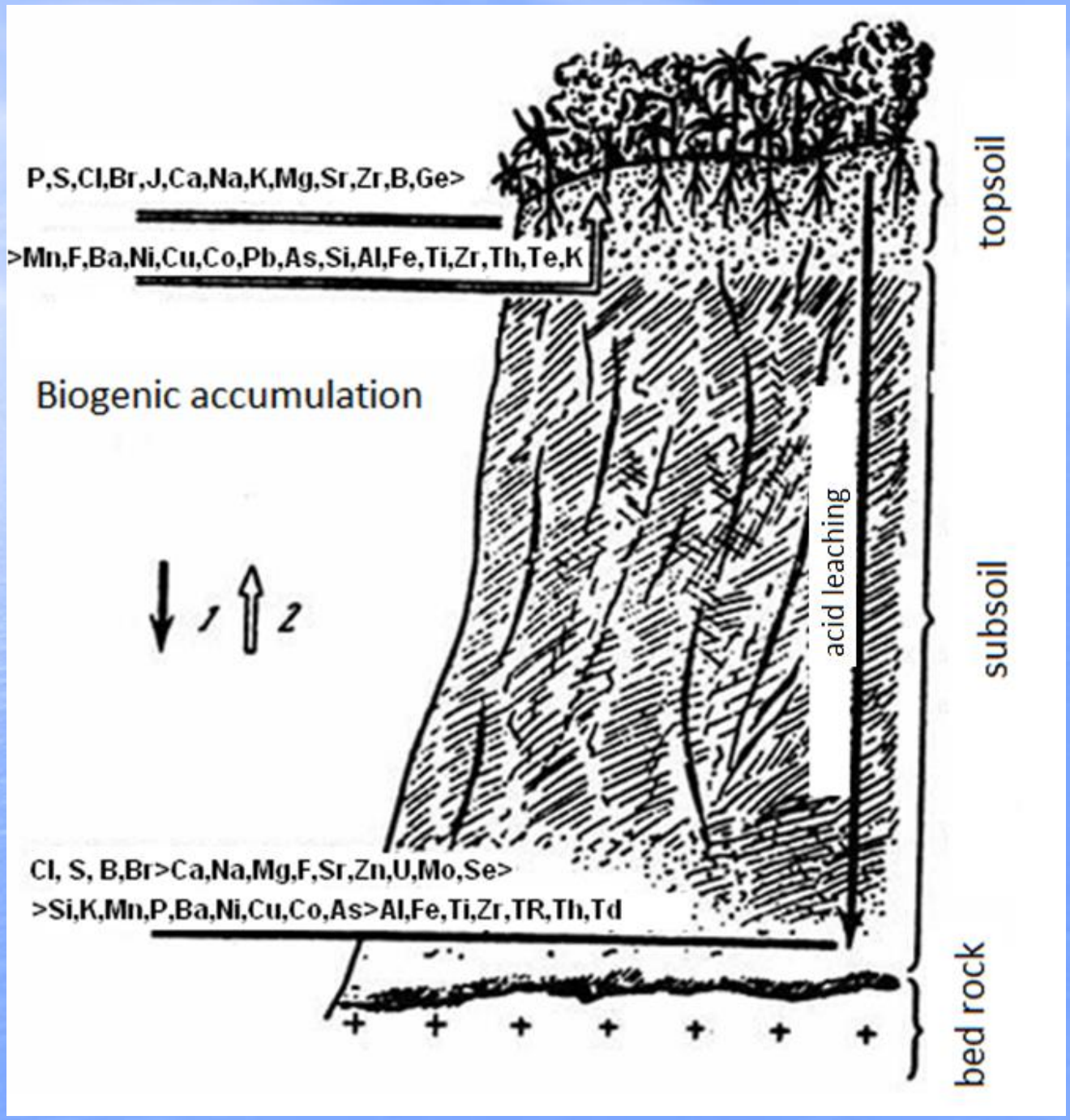


Texture soil triangle

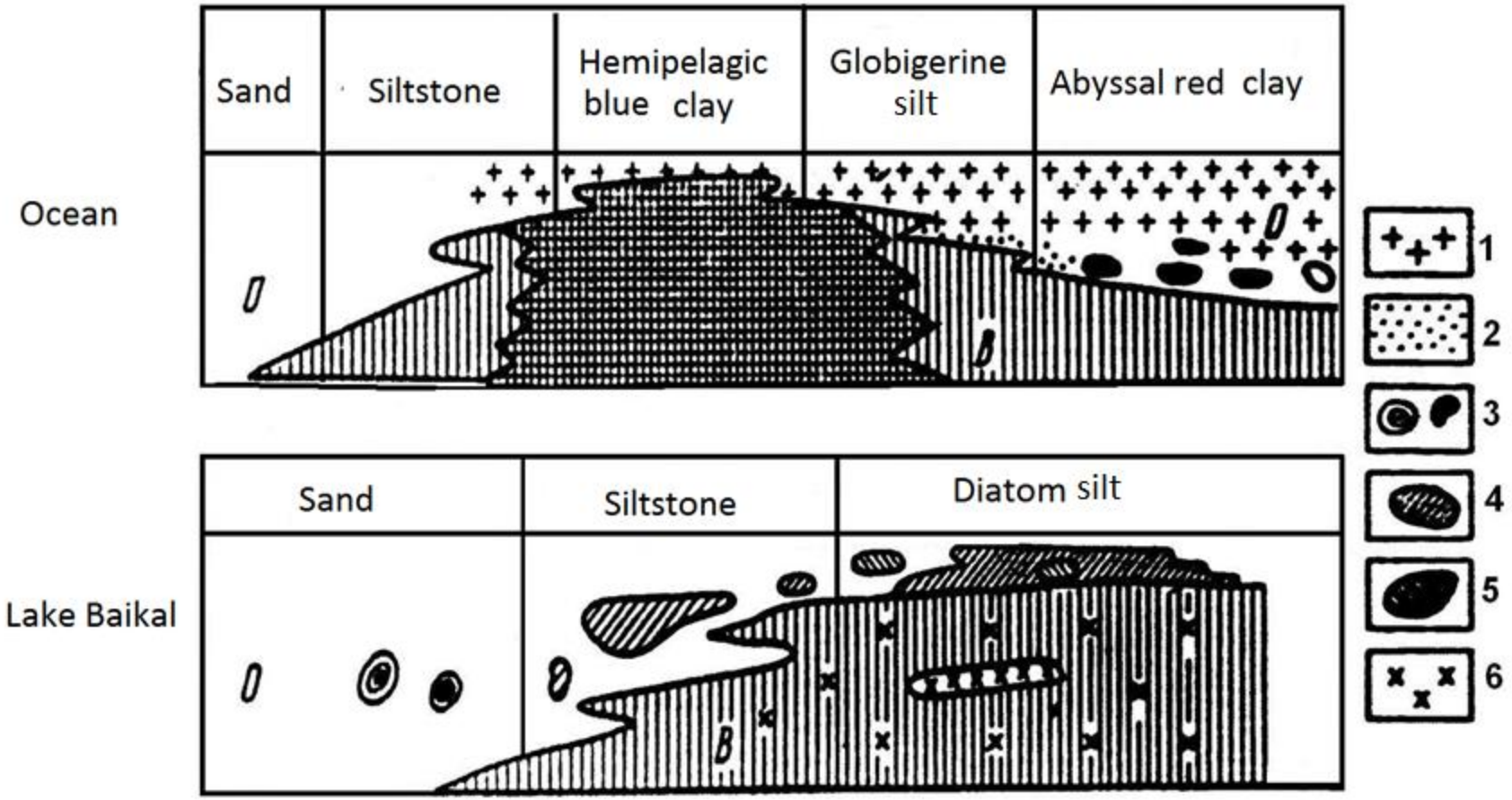
Relationships
between soil texture and its physico-chemical properties

Soil types	Water infiltration	Potential recharge	Ion-exchange capacity	Aeration	Cultivation
sand	good	low	low	free	good
silt	medium	medium	average	average	medium
clay	bad	high	high	poor	bad
clay loam	medium	medium	average	average	medium




P,S,Cl,Br,J,Ca,Na,K,Mg,Sr,Zr,B,Ge>
>Mn,F,Ba,Ni,Cu,Co,Pb,As,Si,Al,Fe,Ti,Zr,Th,Te,K
Biogenic accumulation
1
2
acid leaching
Cl, S, B,Br>Ca,Na,Mg,F,Sr,Zn,U,Mo,Se>
>Si,K,Mn,P,Ba,Ni,Cu,Co,As>Al,Fe,Ti,Zr,TR,Th,Td
topsoil
subsoil
bed rock

Zonal sequence of soils



Human impact on lithosphere and pedosphere

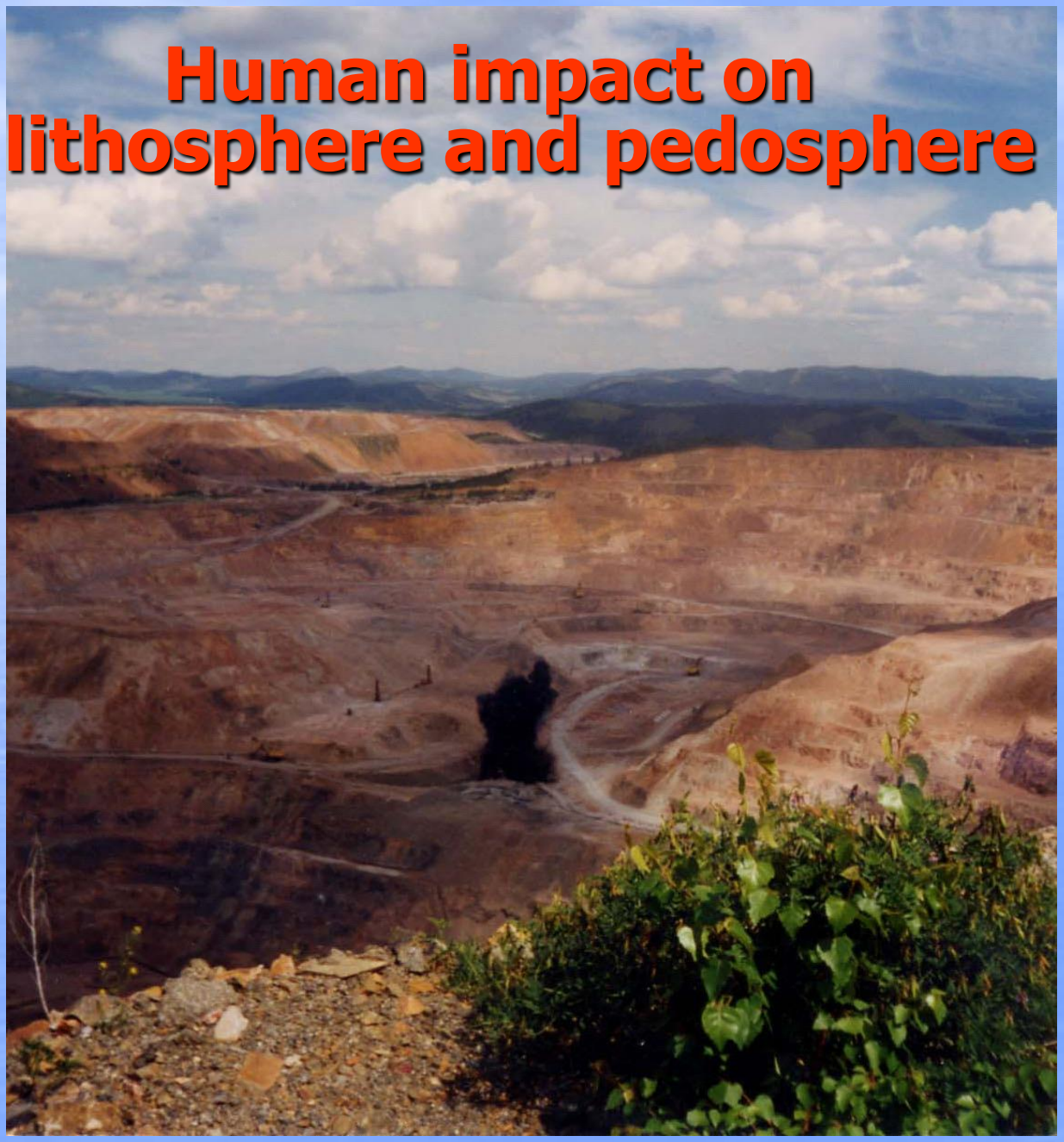



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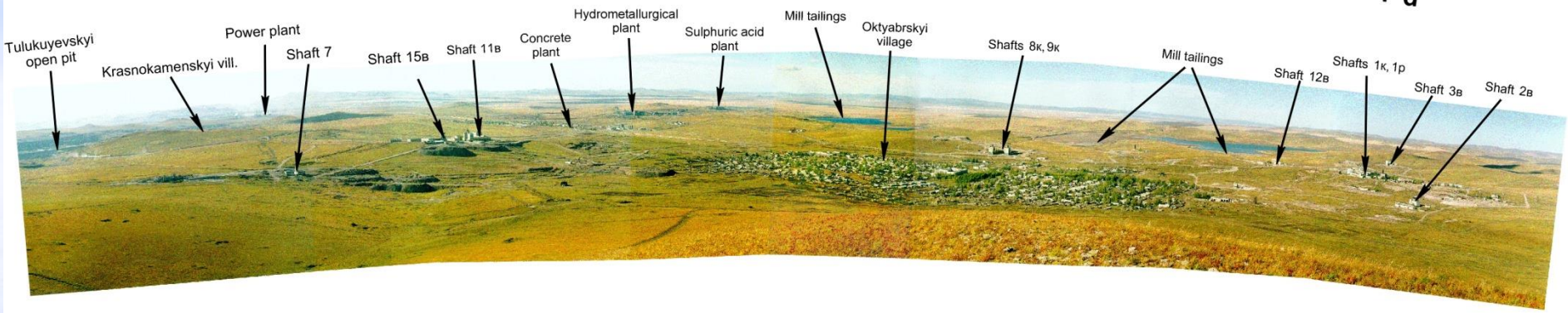
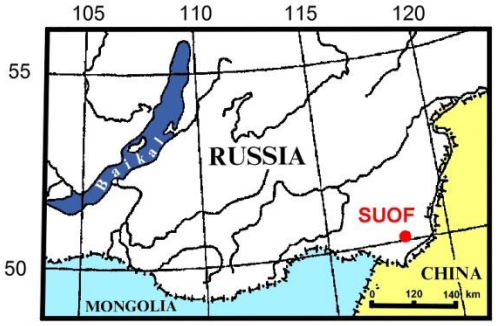
Fig.2. Multi-layered Khakassia relief highlights the ancient soil denudation

View of JSC PIMCU facilities

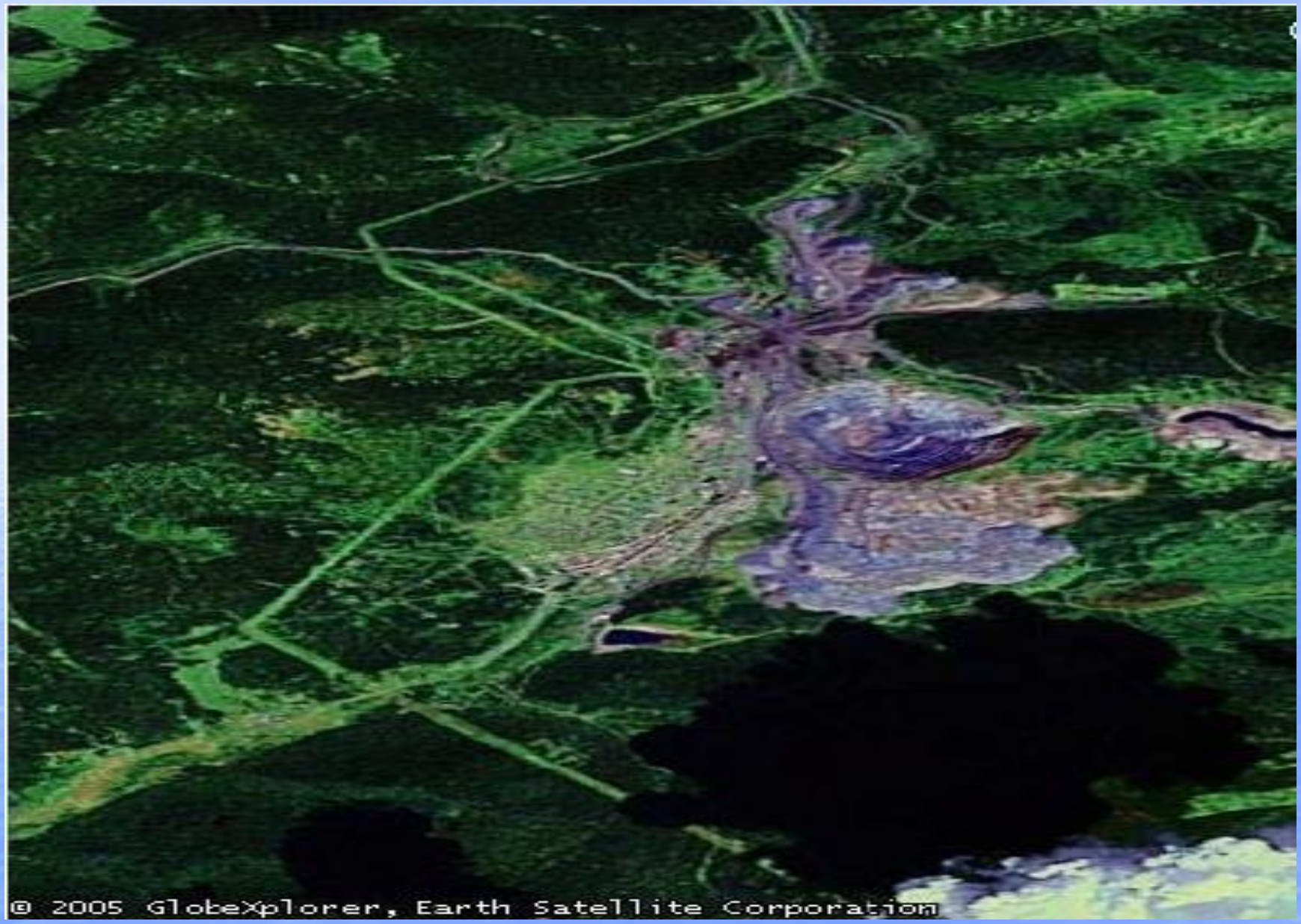
Panorama of the Streltsovskoye uranium ore field



Location of the Streltsovskoye uranium ore field (SUOF)



Tulukuyev open pit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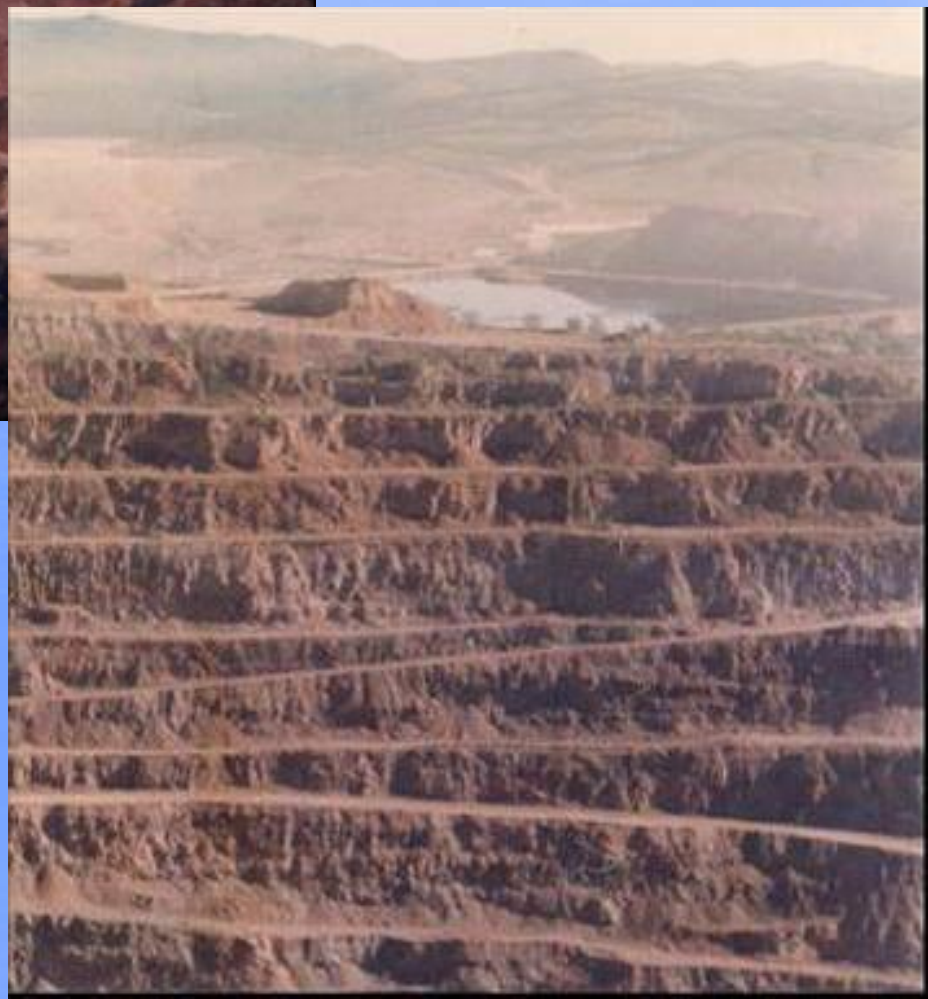



KOLCHAN.RU Personal site from Siberia

Products of sulfur – pyrite volcanoes
(E.F.Emlin,1991)

1. Inner, dry zone, often with reductive conditions within melting zones.

1.1. End melting products of ores and rocks:

- Displaced after melting (microintrusion, intrusive breccia);
- Undisplaced;
- Complete melting;
- Partial remelting, high temperature.

1.2. Deposit products from gas fumes, dust discharges.

1.3. Zone of thermal dispersed rocks, often in oxidation environment.

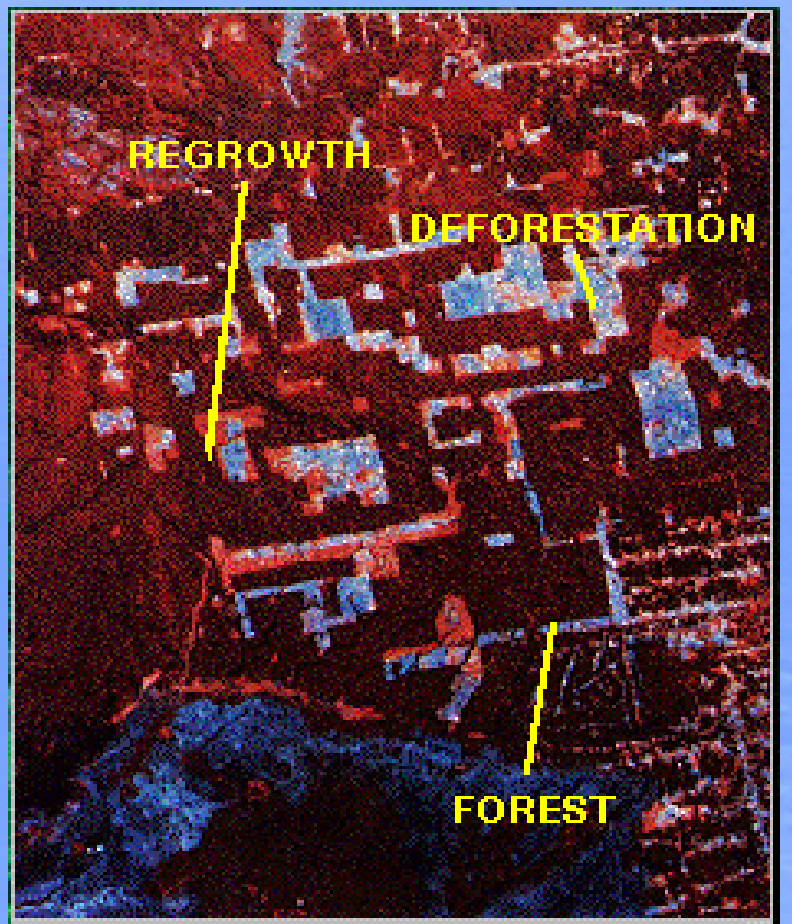
2. External zone of condensated water impact, hydrothermal solutions.

- Sulphate breccia, dykes, dripstones.
- Residual products of acid leaching.
- Crusts, efflorescence and solfatara and fumarole deposition.
- Silt and salts, clastic sediments of groundwater flows.

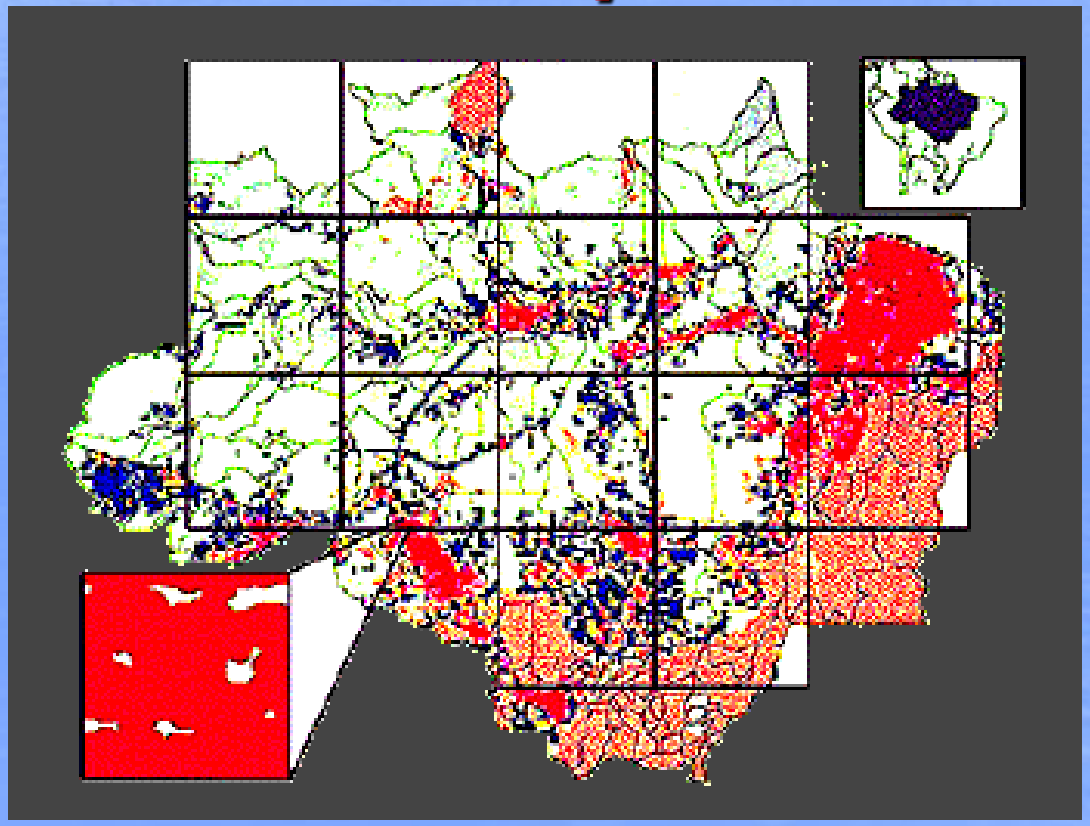
3. Clastic formations as result of depression in volcanic zones and explosions.

Soil erosion

- Soil erosion as a result of deforestation in Madagascar (airborne survey , 1987) and Brazil (1988).

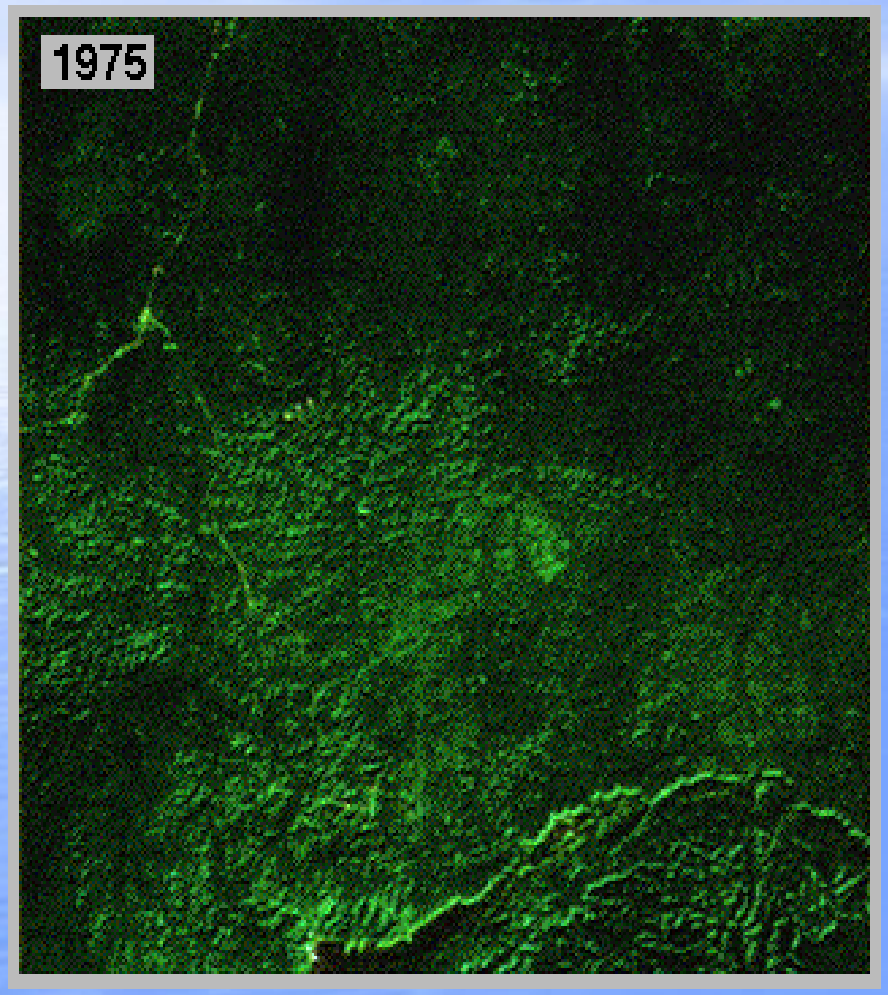


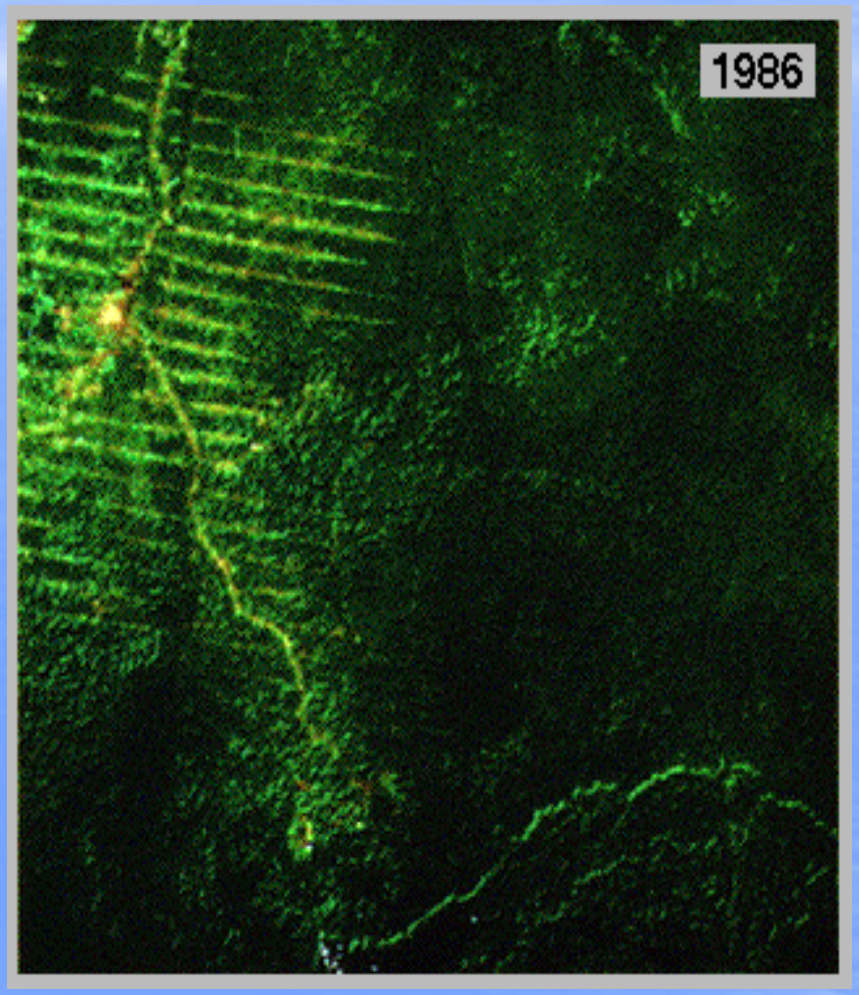
This figure shows areas in the Brazilian Amazon Basin where biological diversity was adversely affected by deforestation and isolation of forest in 1988, and the 1-kilometer long edge effect in consequence of adjacent areas deforestation. Red color represents areas that were mostly affected.



- The forest area before deforestation was 4,092,831 square kilometers.

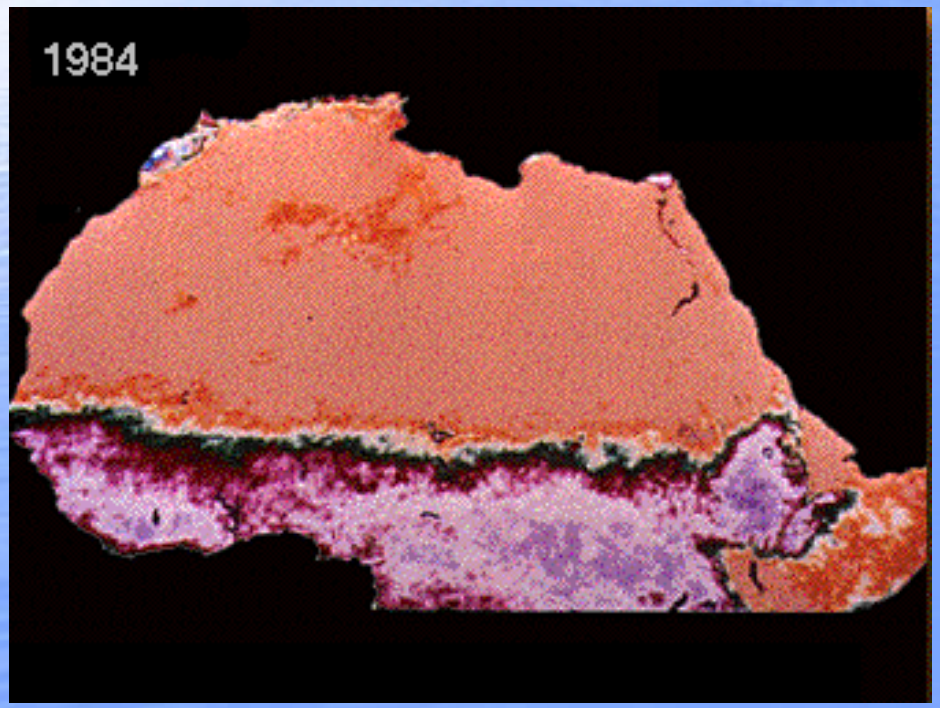
YEAR	DEFORESTED (km^2)	ISOLATED (km^2)	EDGE EFFECT (km^2)	TOTAL (km^2)
1978	78,268	5,115	124,846	208,229
1988	230,324	16,228	341,052	587,607

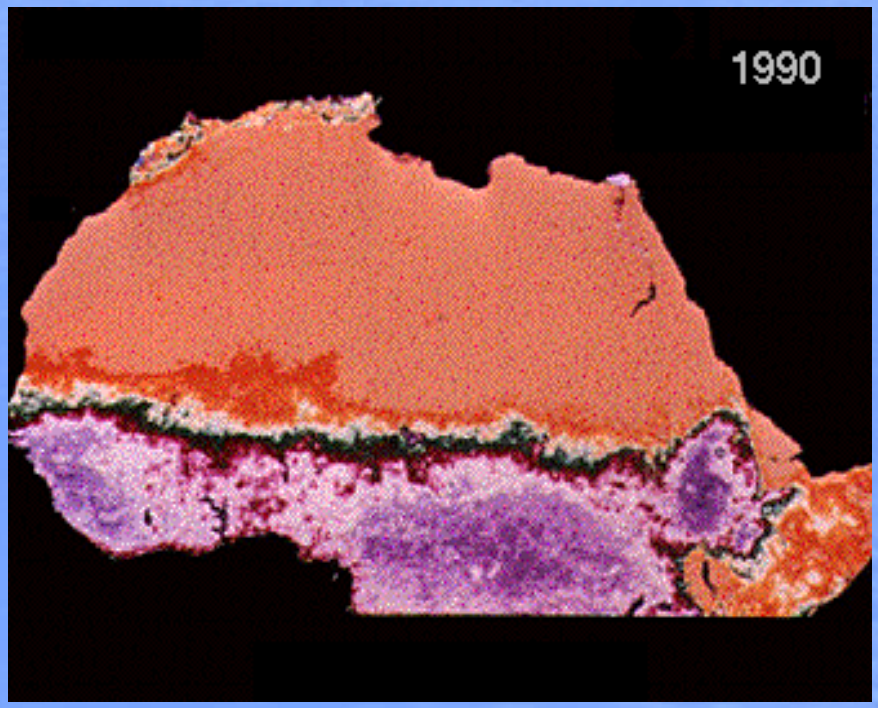

1975

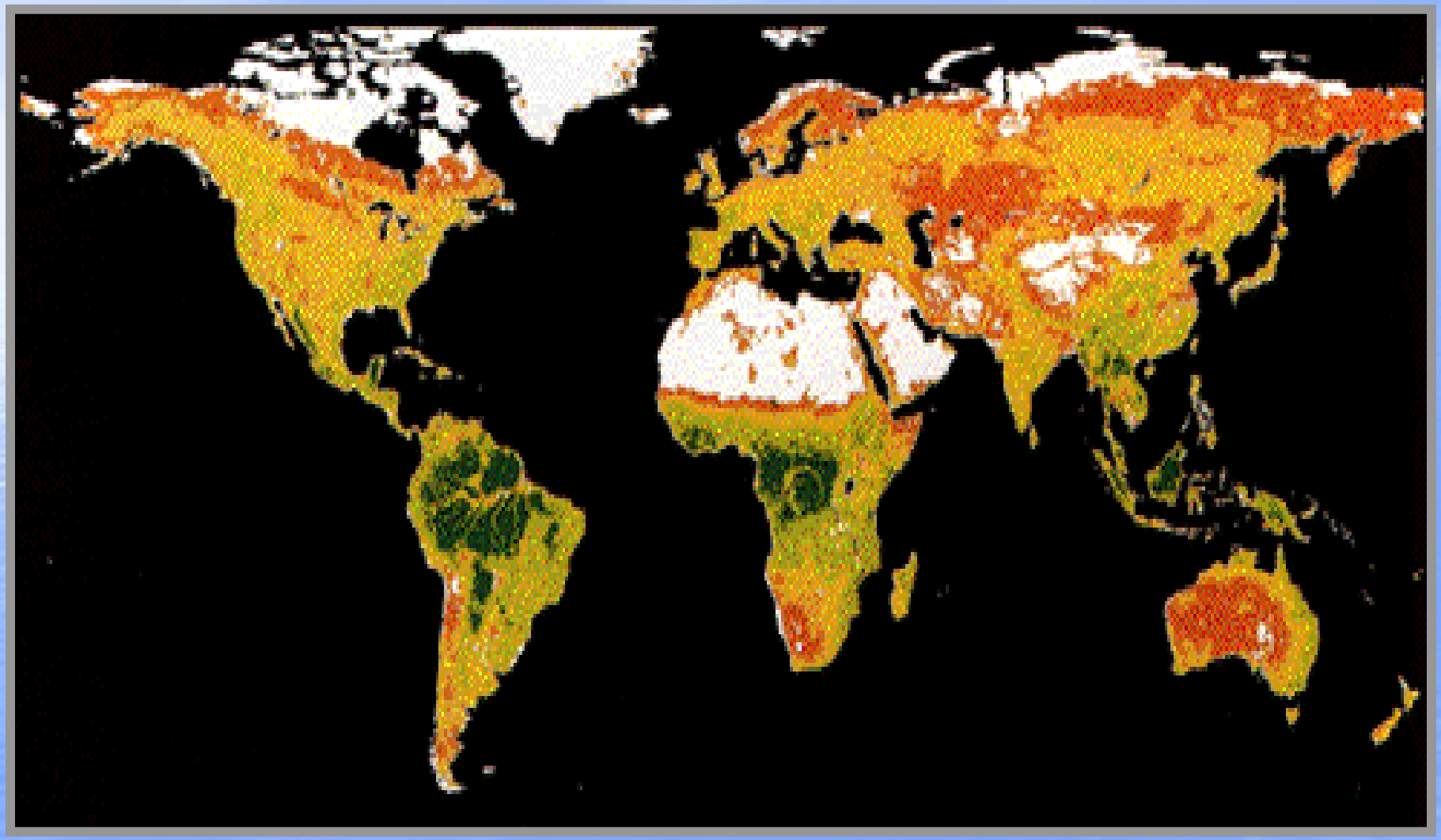

1986

Desertification

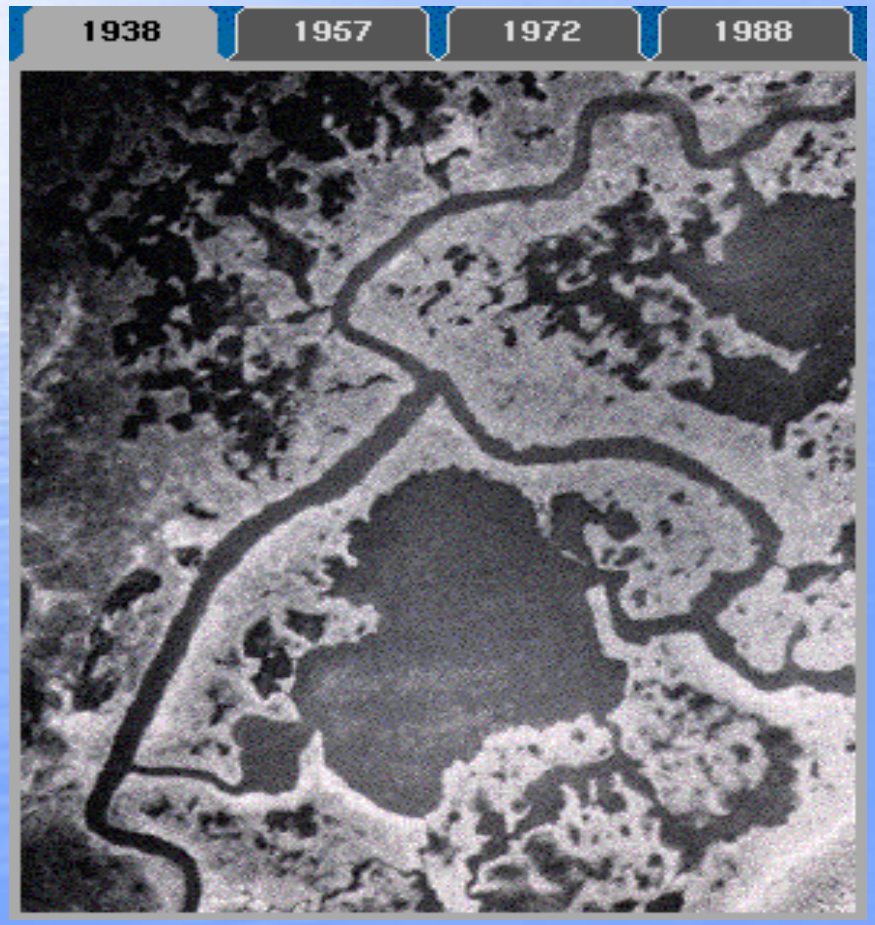
- These comparative figures show that the Sahara Desert had contracted from 1984 to 1990, but it does not mean that Sahara has become smaller. Between 1980 and 1984, the Desert steadily expanded. During this 4-year period, the Sahara has spread southward up to 240 kms.

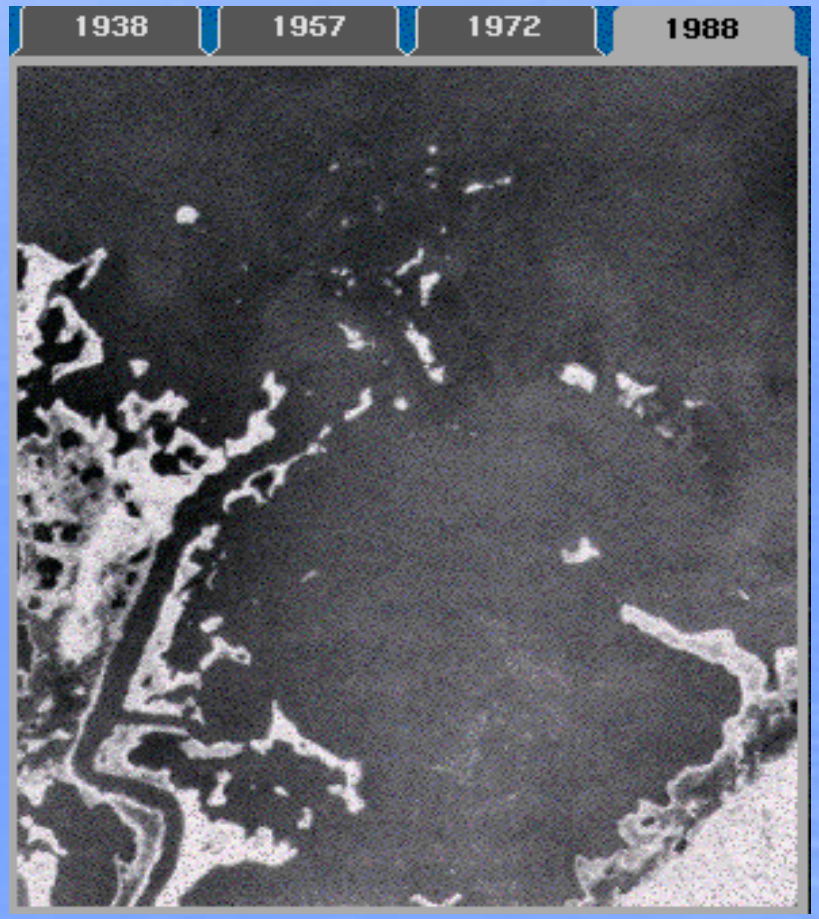






- **These vertical aerial photographs of the Big and Little Blackwater Rivers on the eastern shore of Maryland indicate the progressive formation of small swamps into big ones.**





Desertification has impact on both the human habitat and global climate.

As you can see, desert sands are the bright surfaces that reflect solar radiation (mainly in Africa). An increase in the area of these bright surfaces would result in more solar energy reflected back to space and being less absorbed at the surface. This would tend to area drying up and further desertification.