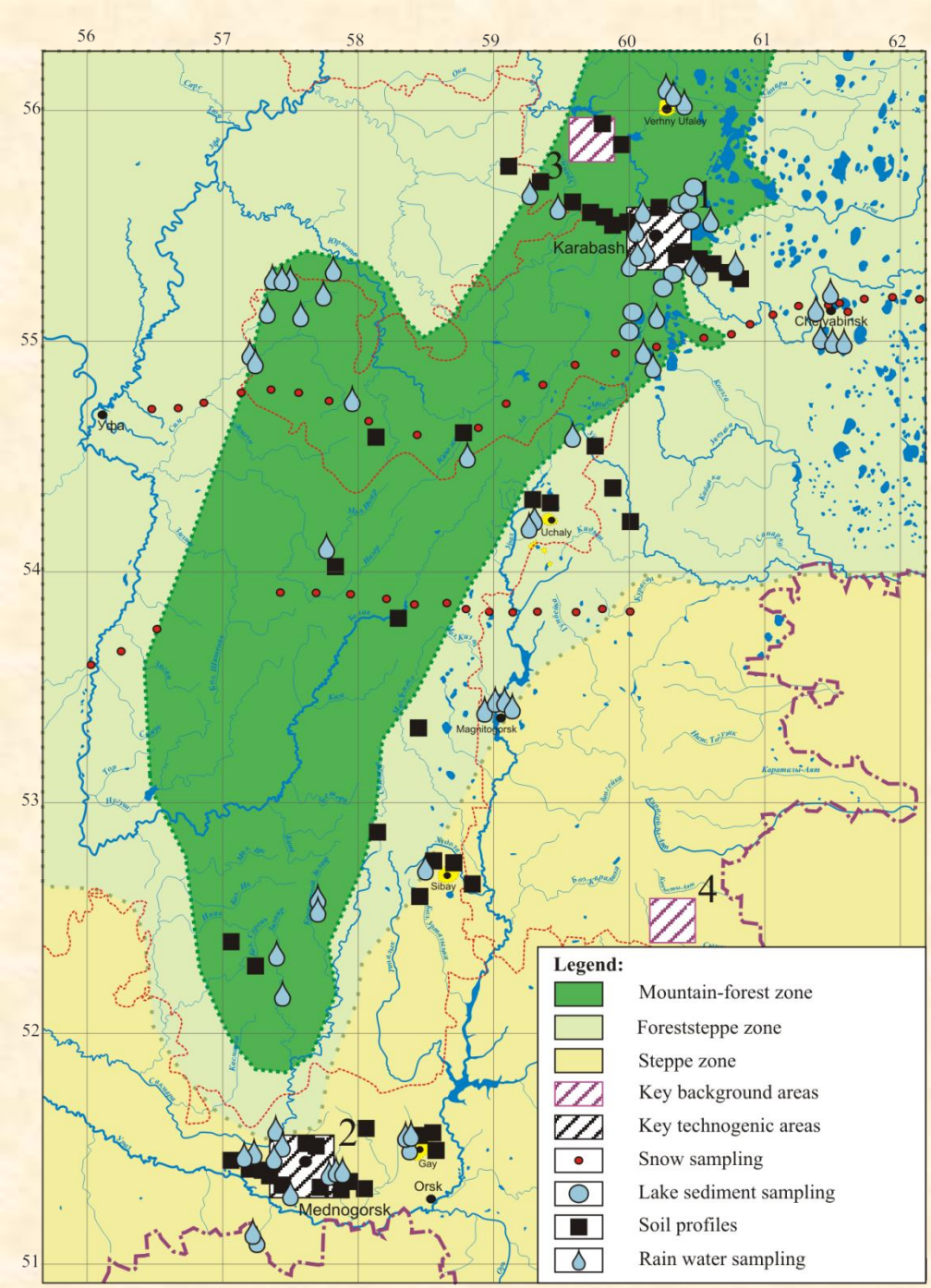
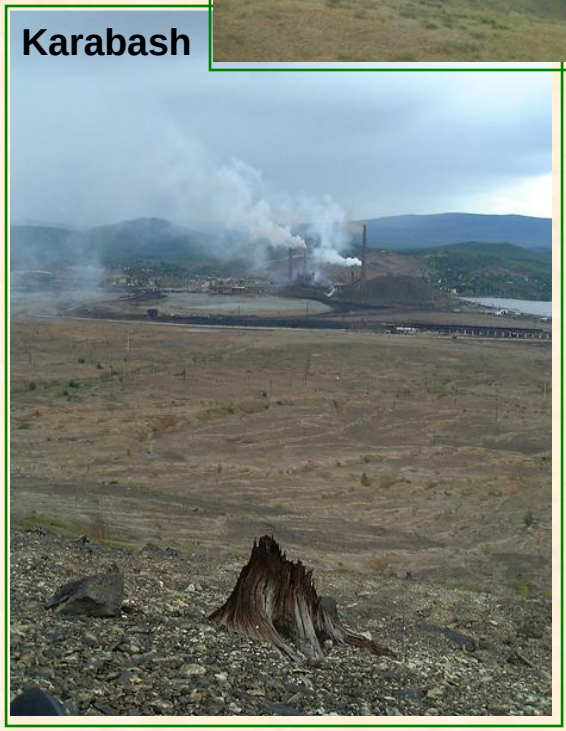
Environmental geochemistry of South Urals geotechnical system (Russia)

ImpactMin Final Event 27-28 November 2012, Kulturenshus, Luleå, Sweden

Aminov Pavel
Udachin Valery
Telenkov Oleg
Institute of Mineralogy UB RAS

Regional landscape-geographic map of South Ural





Knowledge about Karabash

Surface water

Макунина, 1980;
Удачин, 2002;
Белогуб и др., 2003;

Atmospheric transport

Степанов и др., 1992;
Барышева, 2000;
Udachin et al., 2003;
Williamson et al., 2004;
Вильямсон и др., 2005.

Soils

Степанов и др., 1992;
Нестеренко, 1992ф;
Барышева, 2000
Нестеренко, 2006

Lichens

Williamson,
Udachin., 2004;
Spiro et al., 2004;
Purvis et al., 2006.

Accumulation of heavy metals in vegetables

Нестеренко,
Левит, 1989, 1992ф;
Барышева, 2000;
Нестеренко, 2006.

The composition of sediments lakes and streams

Нестеренко, 1992ф;
Барышева, 1999;
Нестеренко, 2006;

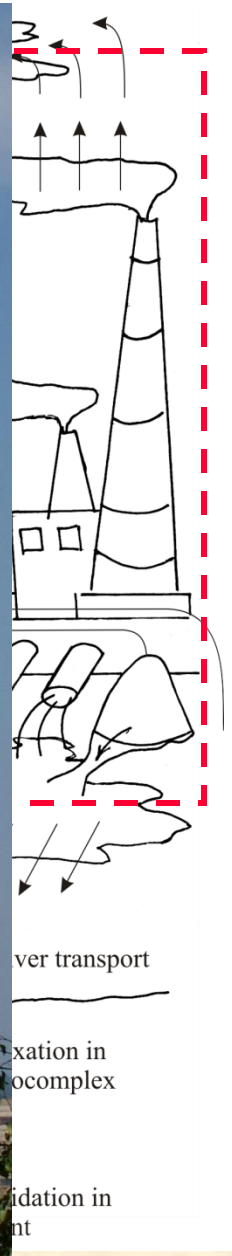
Cenotical structure terrestrial communities

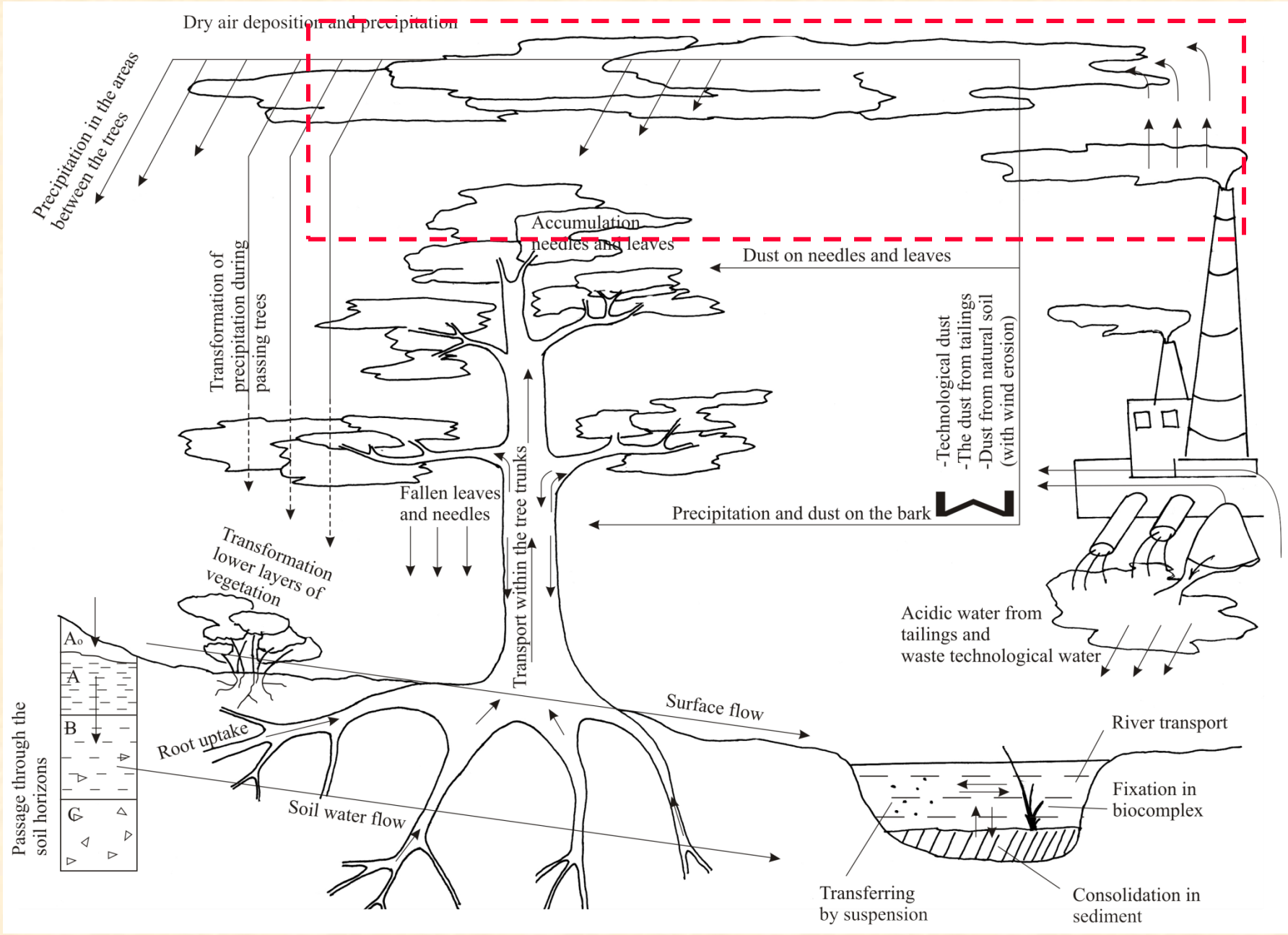
Черненькова, 1986;
Черненькова, 1989;
Степанов и др., 1992;
Черненькова и др., 2001;
Макунина, 2002;
Куянцева,
Вейсберг, 2008.

Composition of the ores, "tails", slags

Кораблев и др., 1992ф;
Усманов, 1995;
Щербакова, 1998;
Кораблев, 2002;
Удачин и др., 2002;
Белогуб и др., 2003;
Ожерельева,
Бортникова, 2006.

Sources of anthropogenic impact in Karabash

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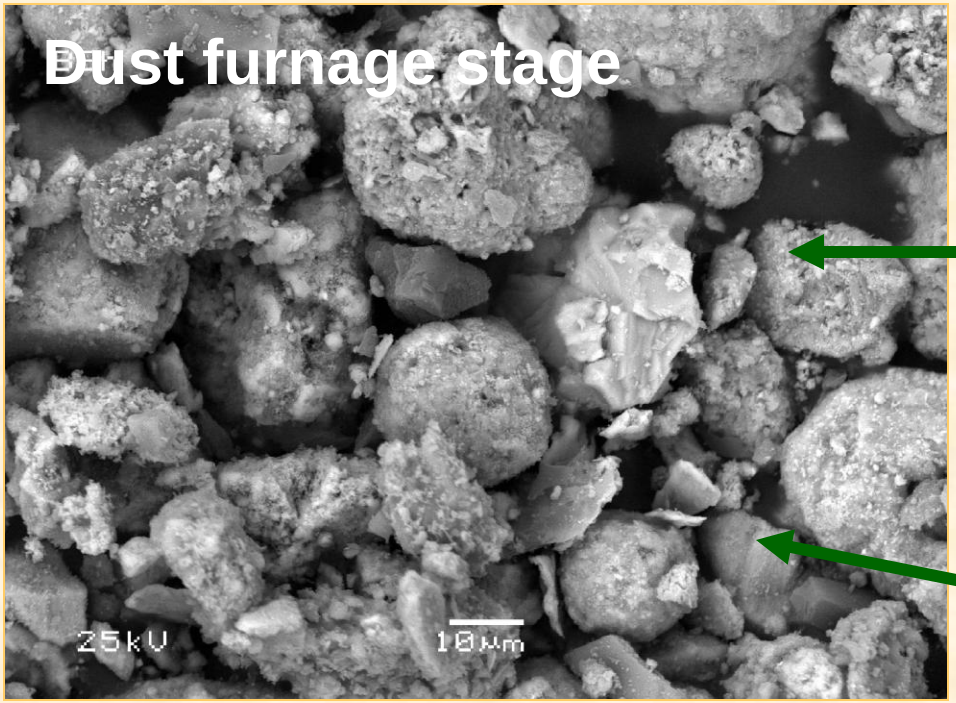
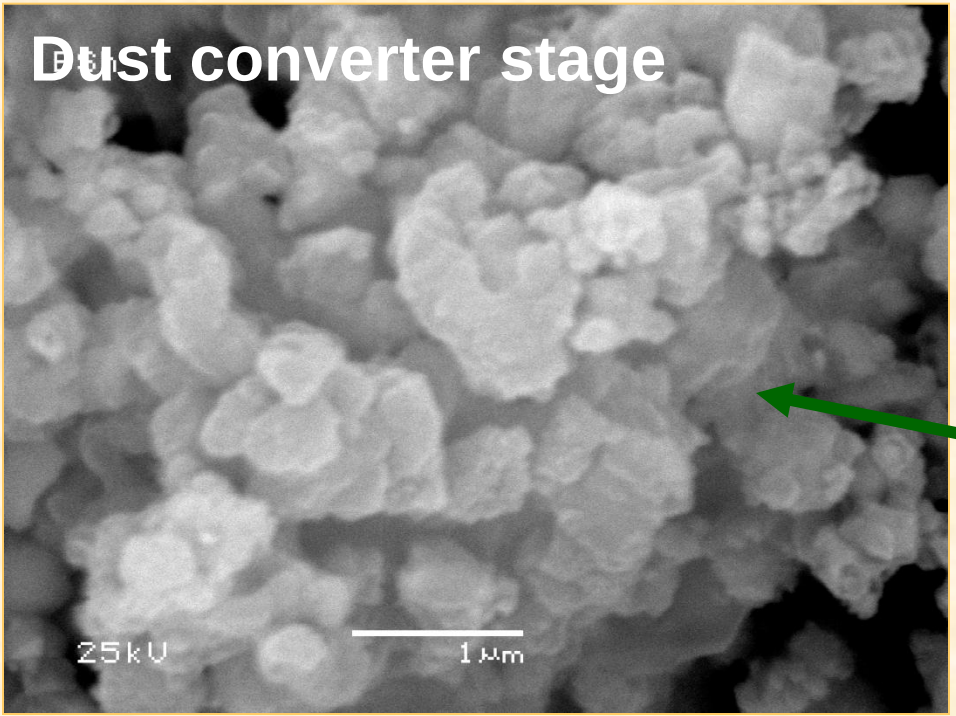
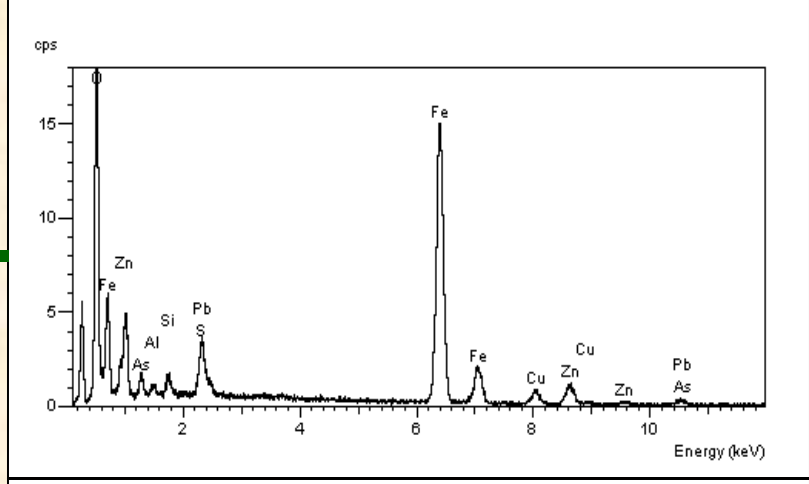
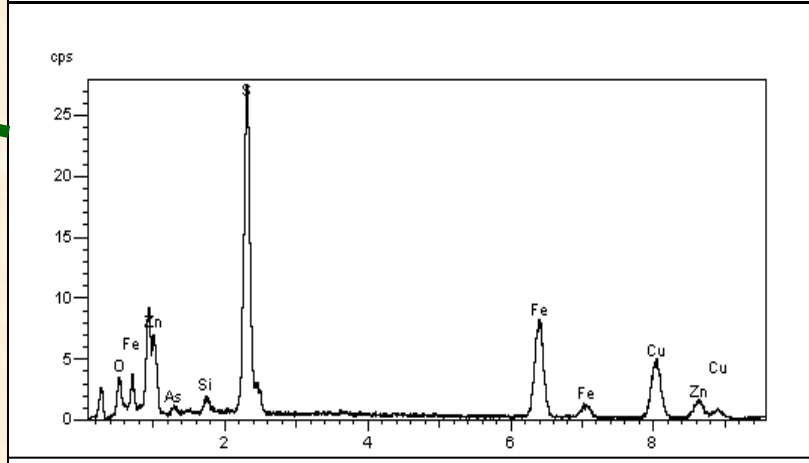
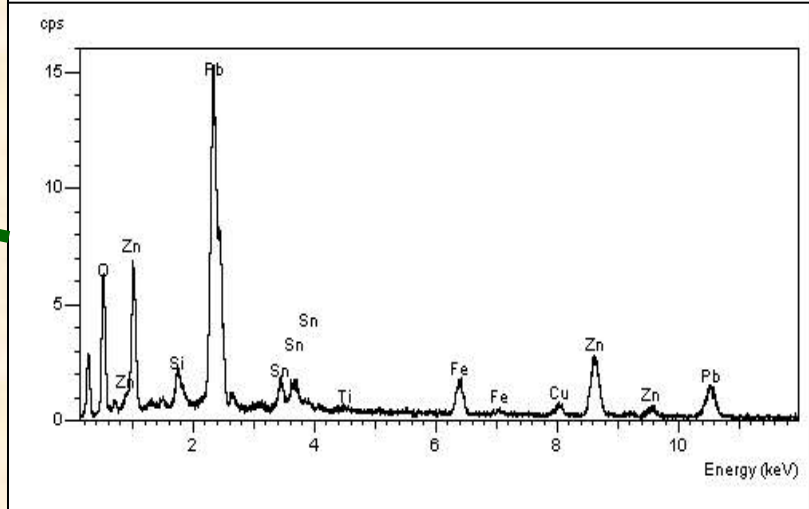
Precipitation in the areas between the trees
Transformation of precipitation during passing trees
Accumulation needles and leaves
Dust on needles and leaves
-Technological dust
-The dust from tailings
-Dust from natural soil (with wind erosion)
Fallen leaves and needles
Transport within the tree trunks
Precipitation and dust on the bark
Transformation lower layers of vegetation
Acidic water from tailings and waste technological water
Passage through the soil horizons
A₀
A
B
G
Root uptake
Surface flow
Soil water flow
River transport
Fixation in biocomplex
Transferring by suspension
Consolidation in sediment


Dust furnage stage
25kV
10µm

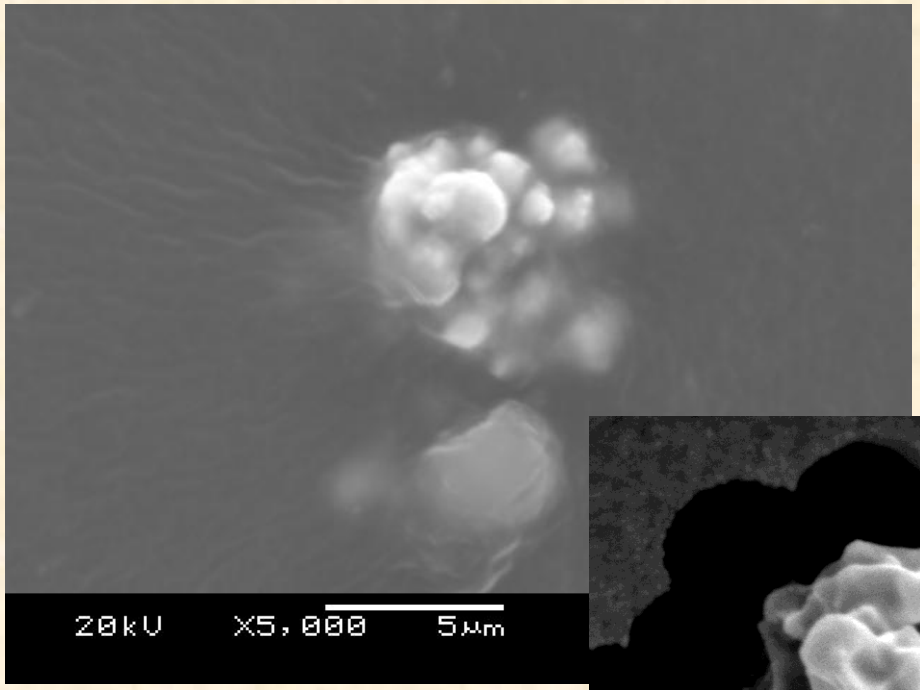

Dust converter stage
25kV
1µm

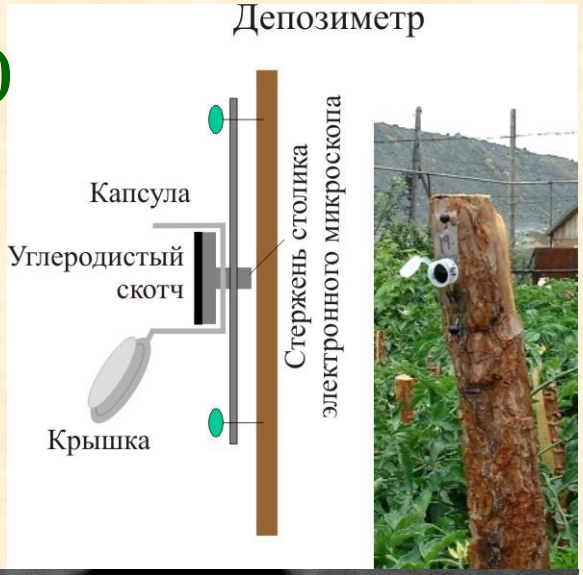

cps
O
Fe
Zn
Fe
Si
Al
As
Pb
S
Fe
Cu
Zn
Cu
Zn
Pb
As
Energy (keV)

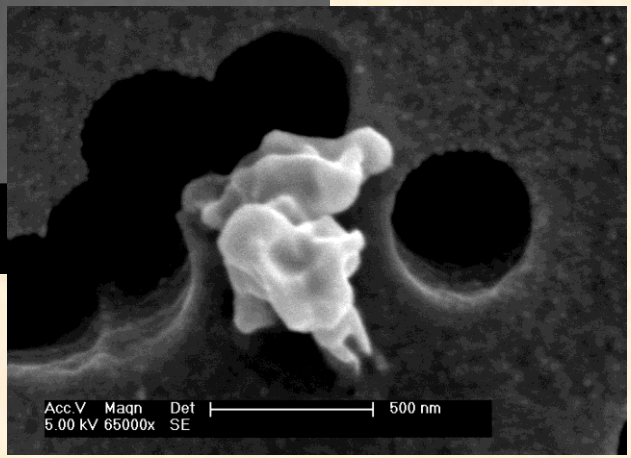

cps
S
O
Fe
Zn
As
Si
Fe
Fe
Cu
Cu
Zn

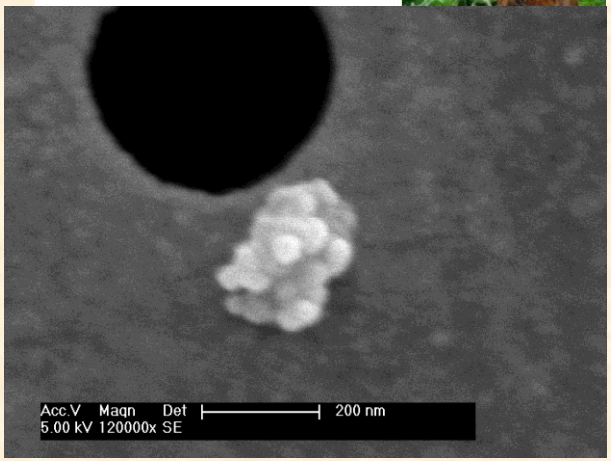

cps
Pb
O
Zn
Zn
Si
Sn
Sn
Sn
Ti
Fe
Fe
Cu
Zn
Zn
Pb
Energy (keV)

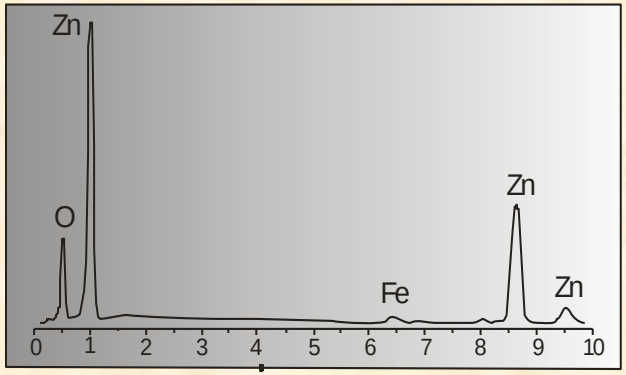
Dry precipitation near copper smelters (SEM)

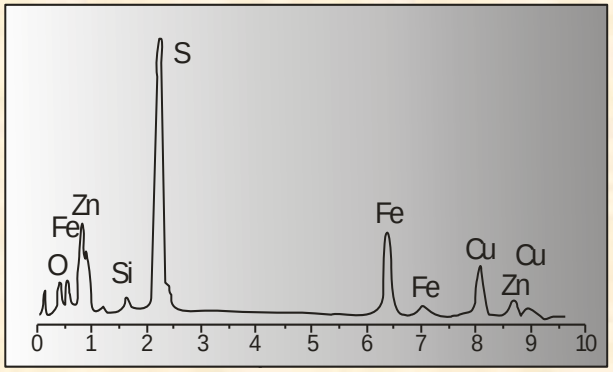


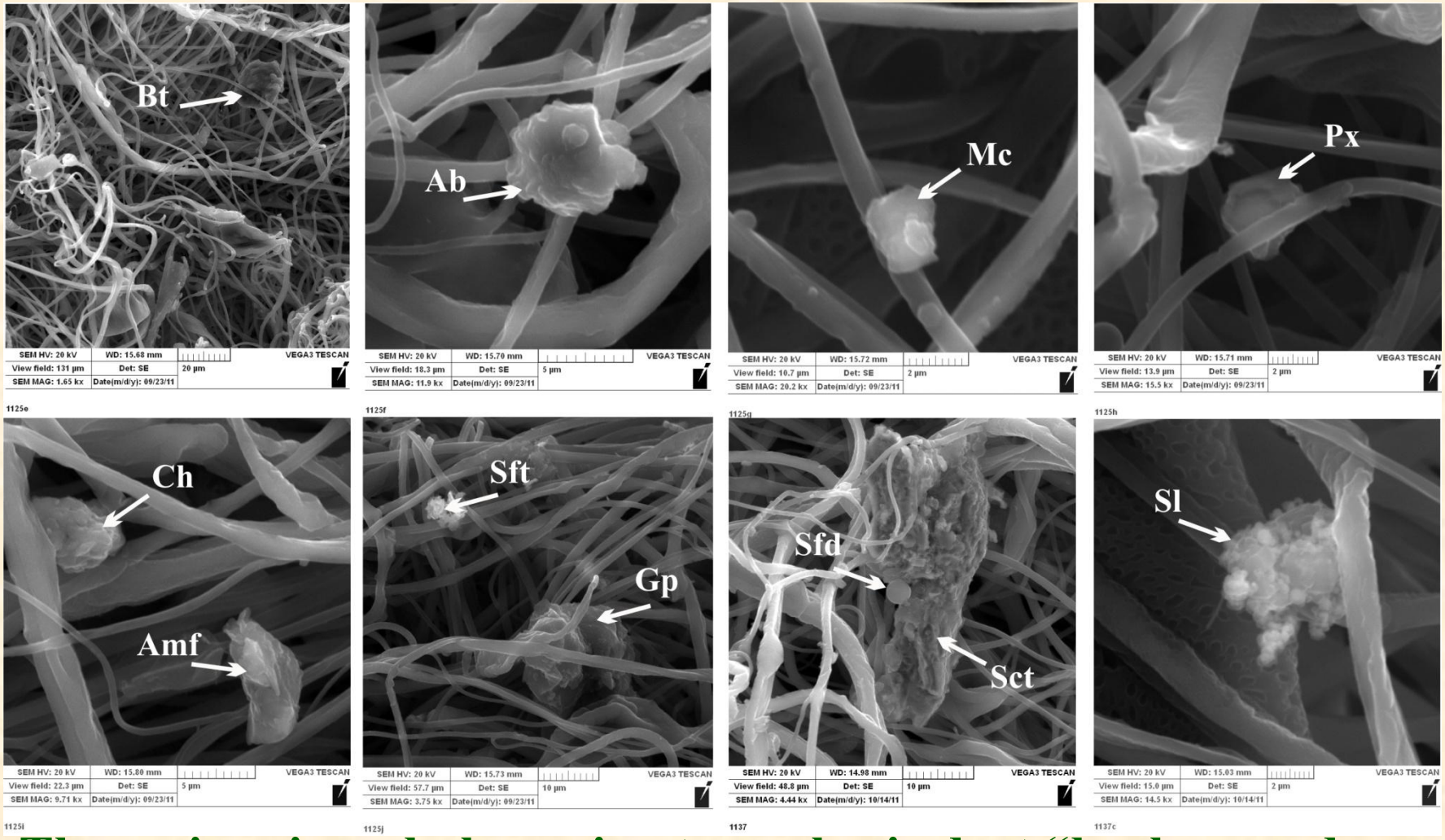












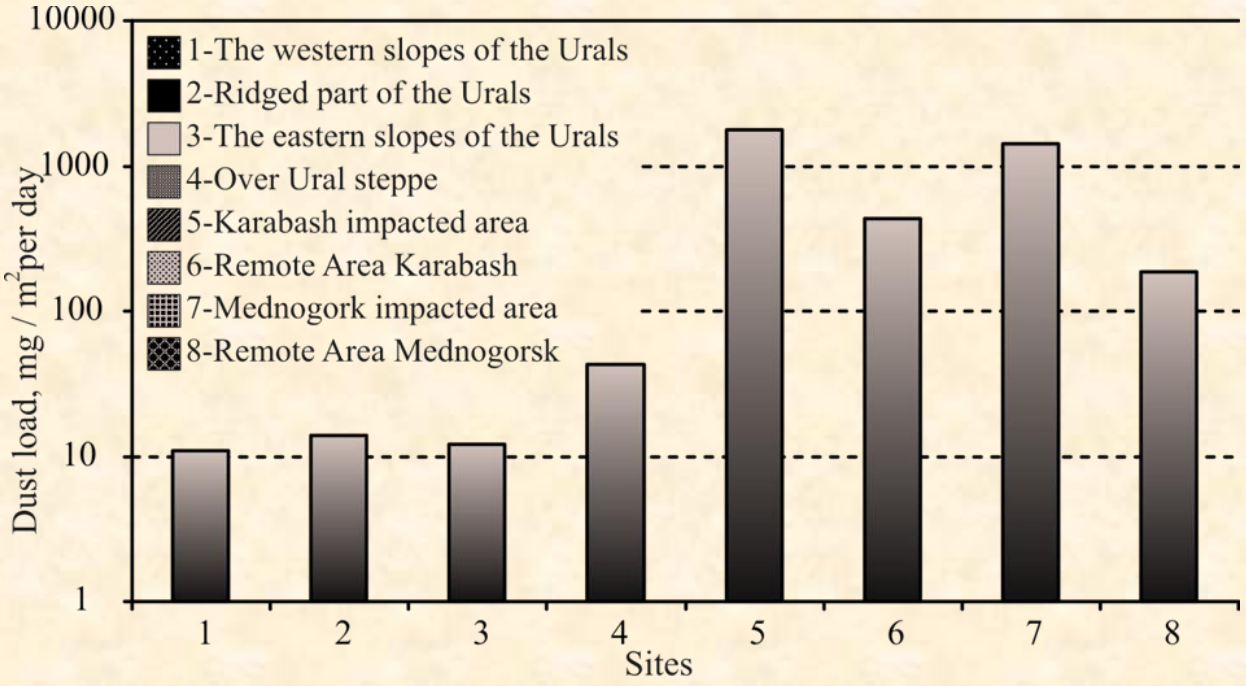
The main mineral phases in atmospheric dust "background area" in the South Urals

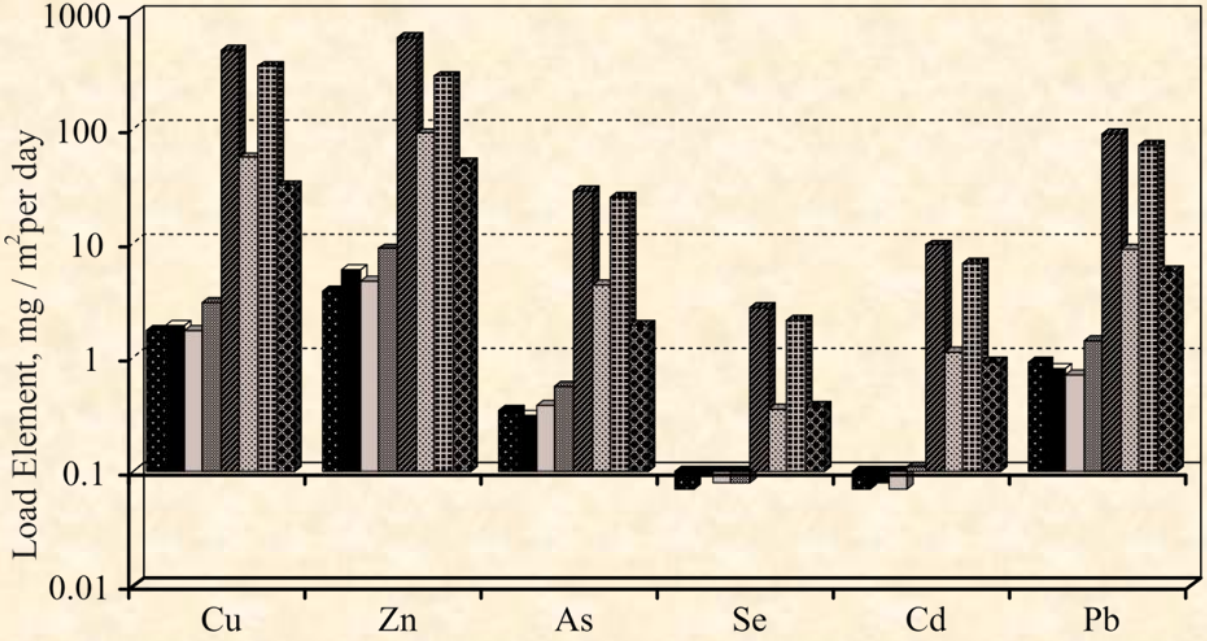
Fragments filter AFA-15, the exposure 3 hours, the air volume of 240 m^3 (Bt - biotite, Ab - albite, Ms - mica, Px - pyroxene, Ch - chlorite, Amf - amphibole, Sft - sulfate, Gp - gypsum, Sfd - sulfide Cu-Ni, Sct - silicate, Sl - soil organic matter).

Snow sampling

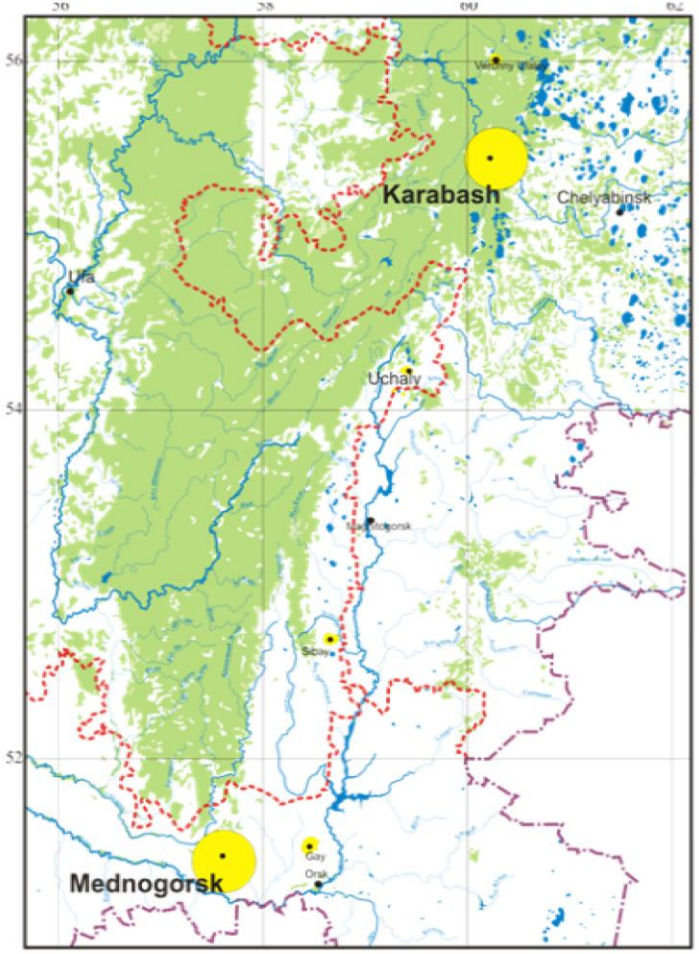
Photo

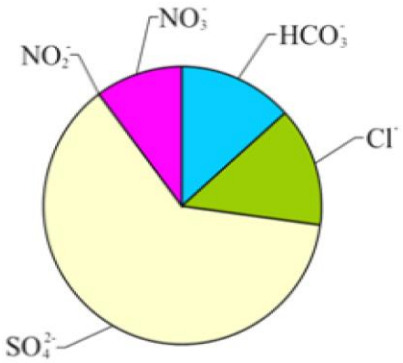
Photo

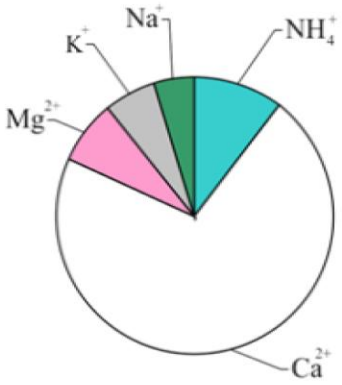


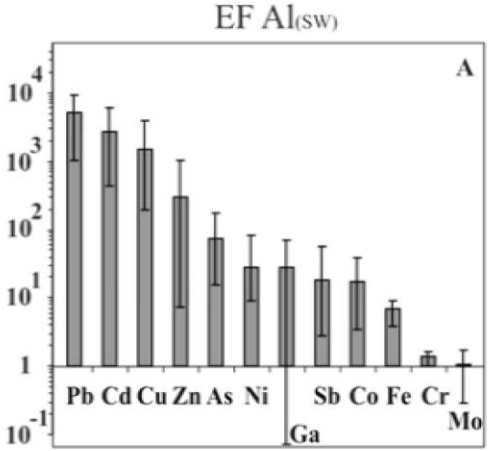


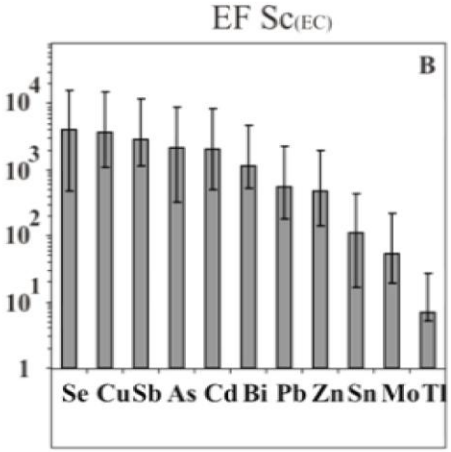
Amount of atmospheric dust and chemical composition in different geographical areas of the Ural



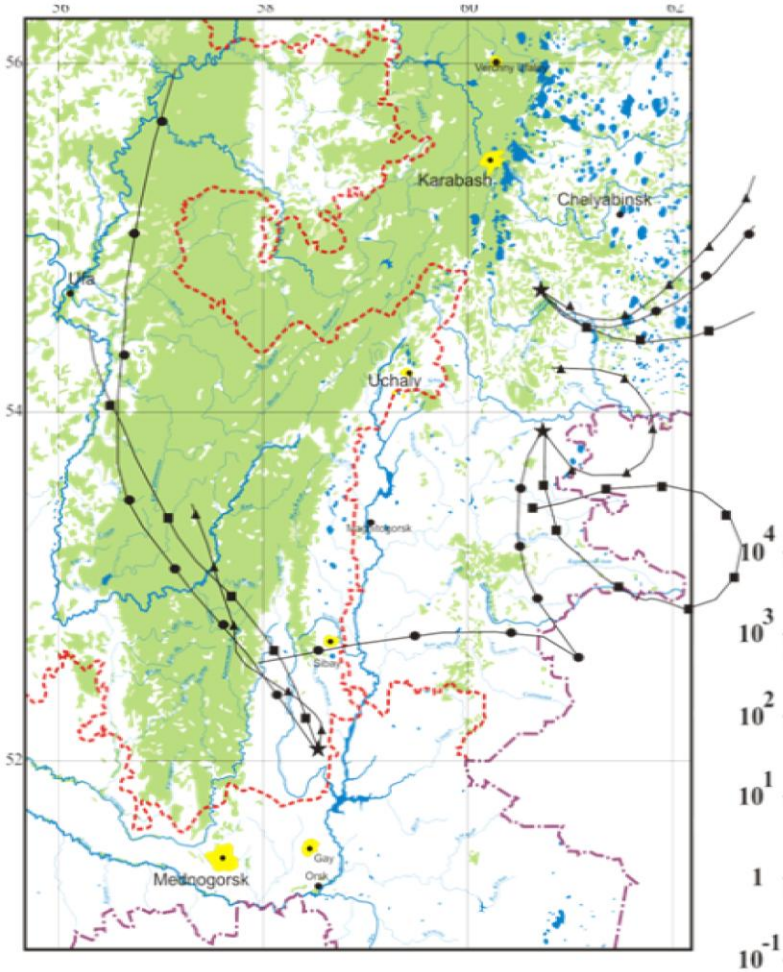


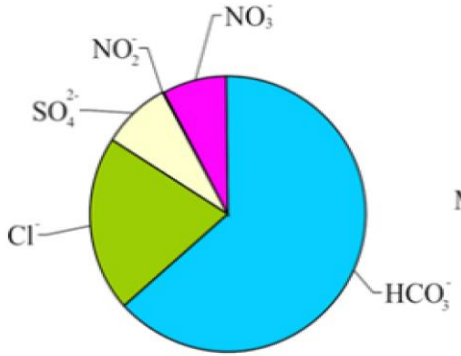


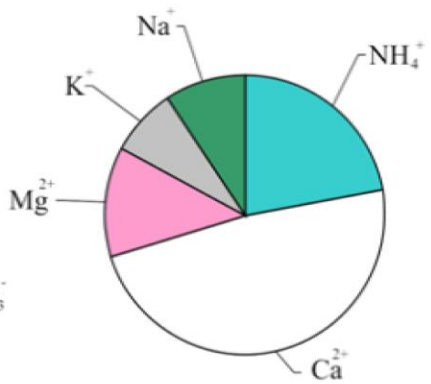


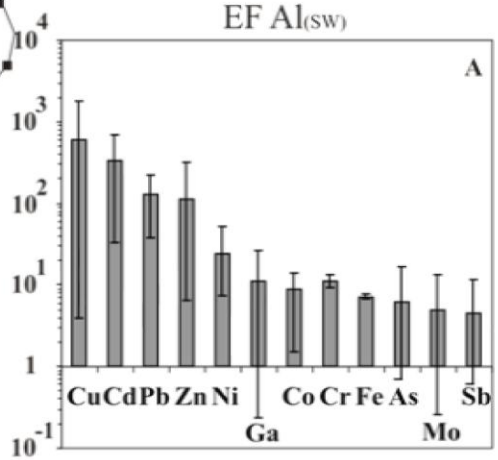


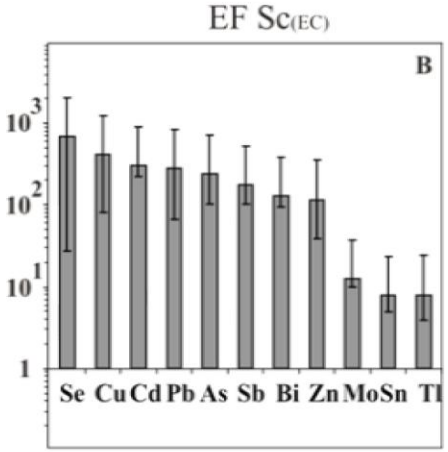
Chemical composition rains and dust in South Ural in the smelting area





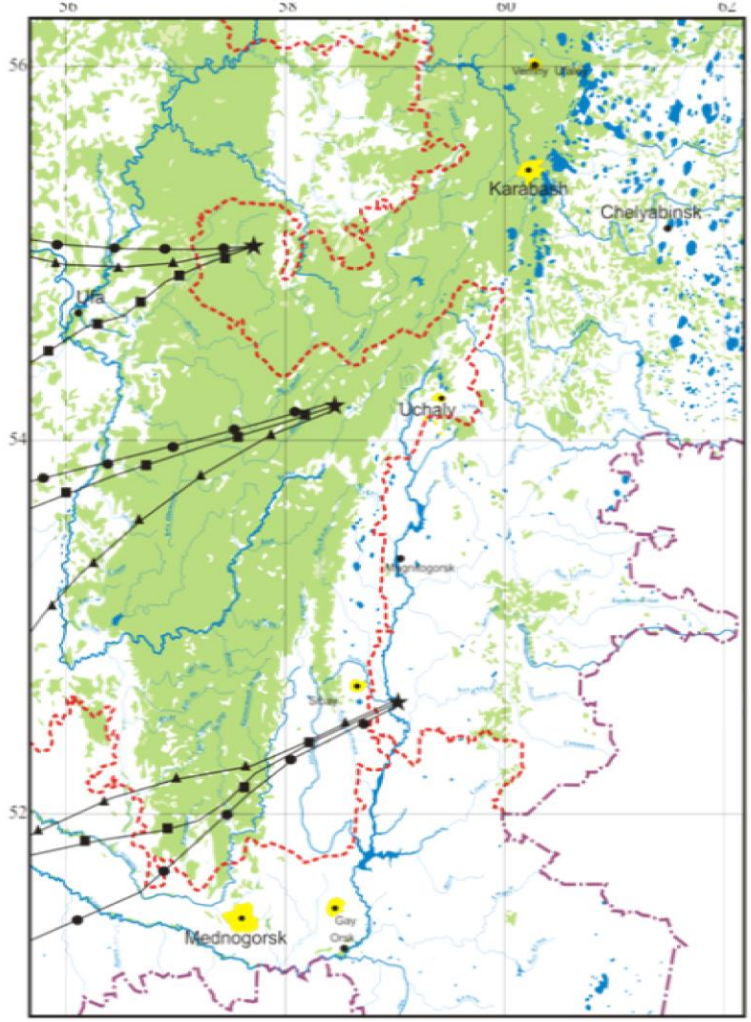


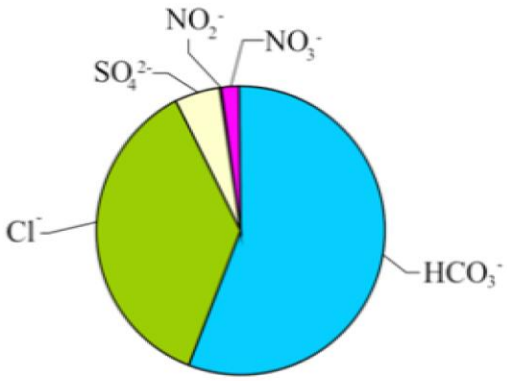


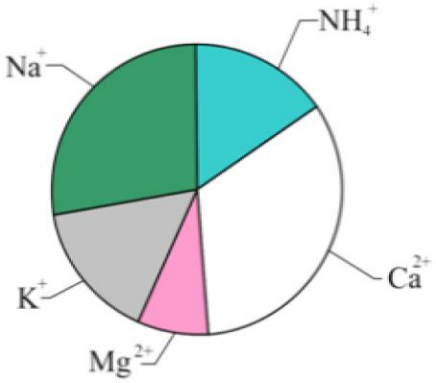


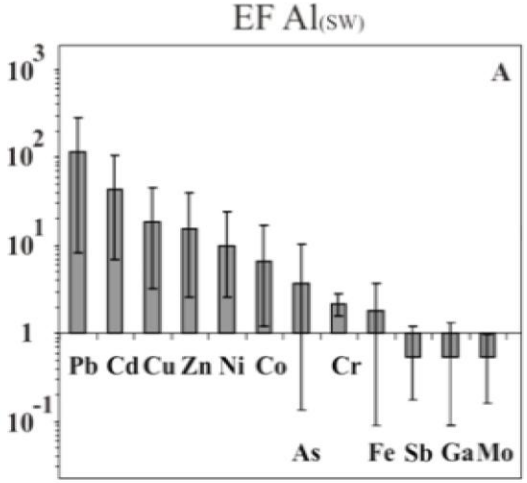
Chemical composition rains and dust in South Ural at "Ural" type migration (method of back trajectories *Hysplit*).

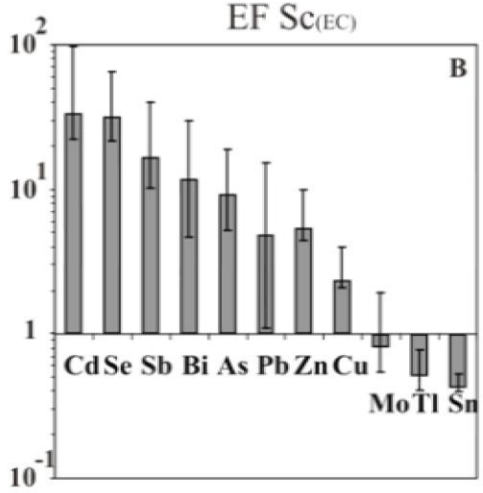
$$EF = \frac{C_i(\text{проба})/C_{Sc}(\text{проба})}{C_i(\text{кларк})/C_{Sc}(\text{кларк})}$$







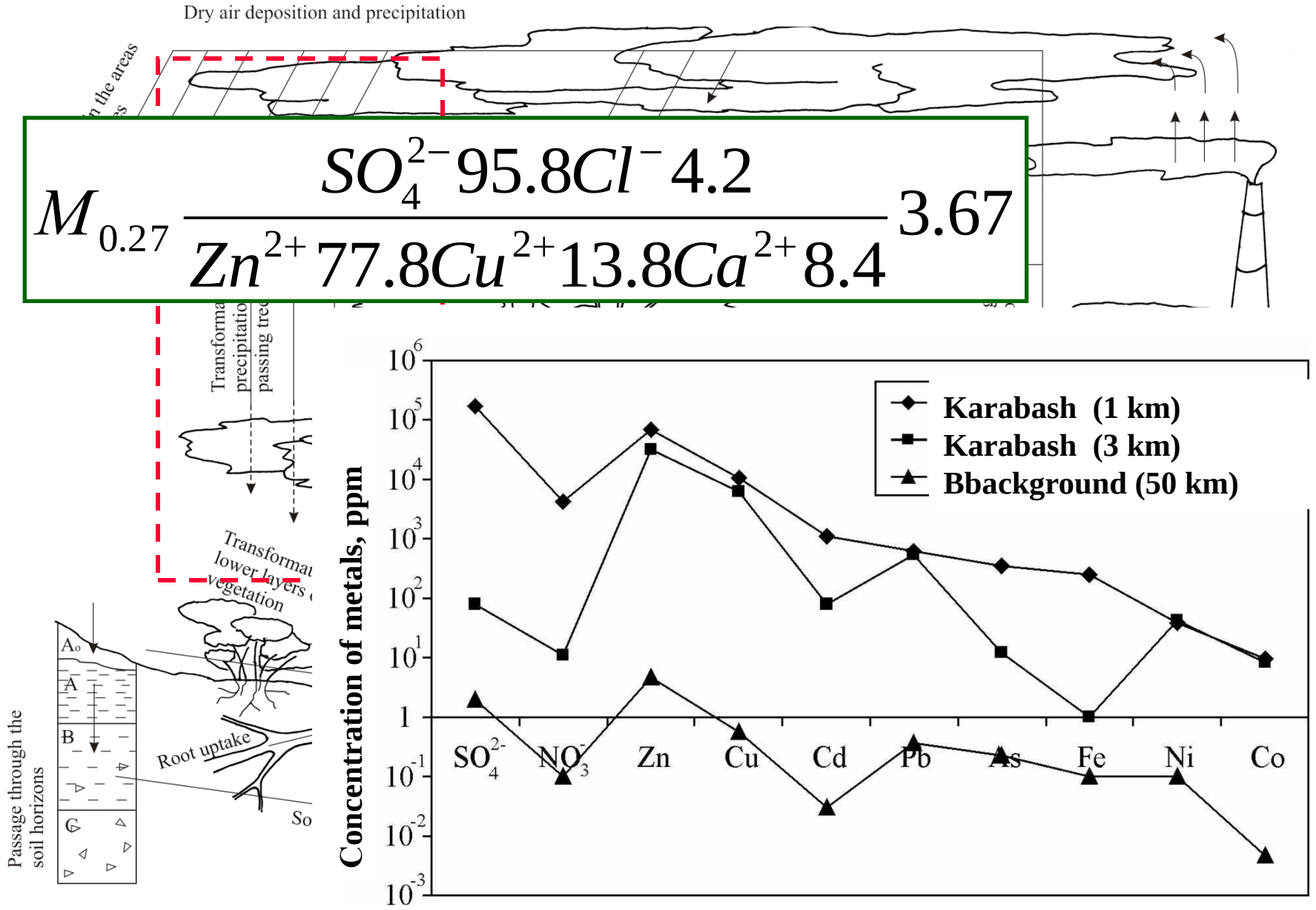


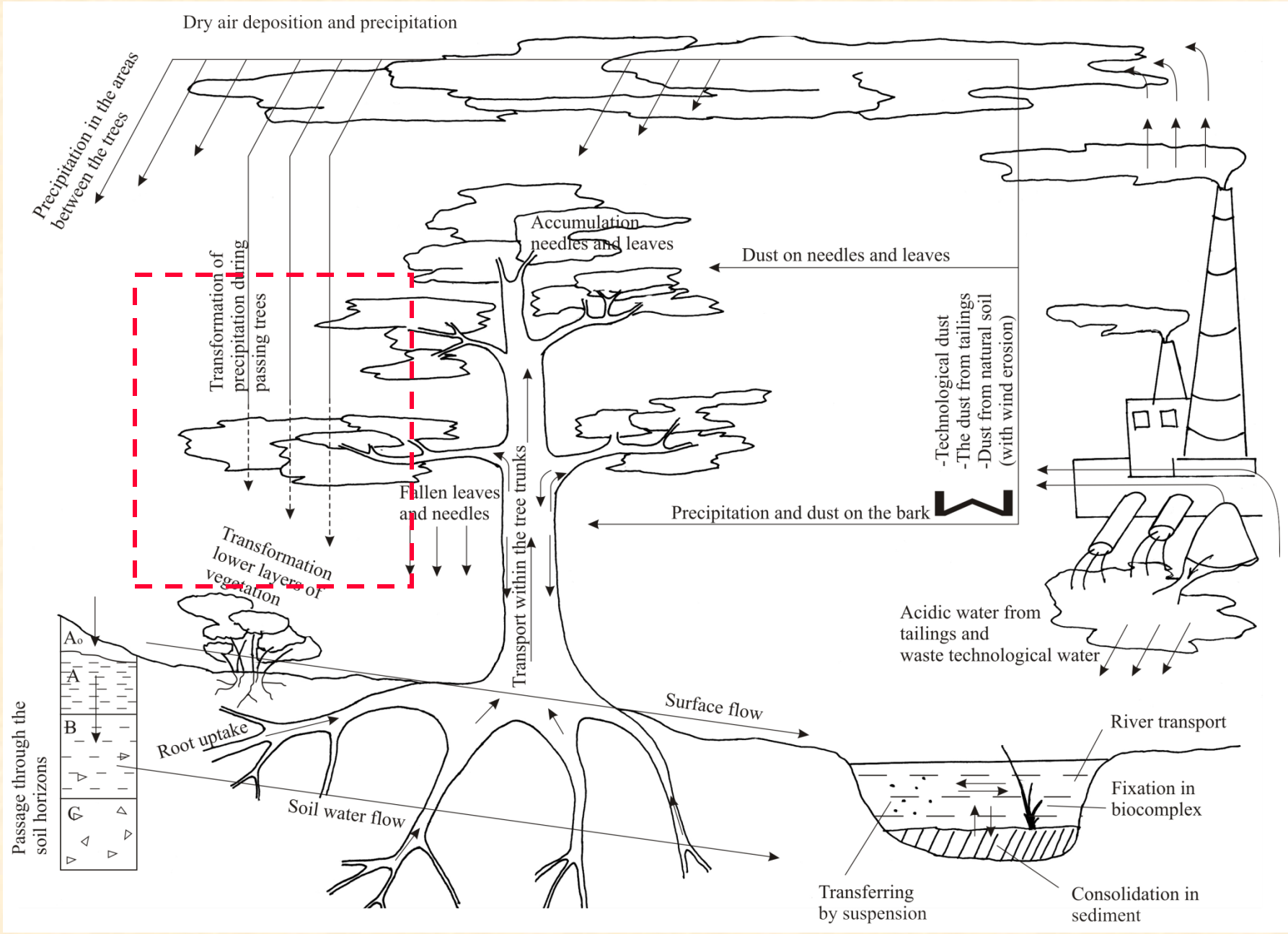


Chemical composition rains and dust in South Ural at “background-west” type migration (method of back trajectories *Hysplit*).

Forming precipitation

$$M_{0.27}\frac{SO_4^{2-}95.8Cl^{-}4.2}{Zn^{2+}77.8Cu^{2+}13.8Ca^{2+}8.4}3.67$$




Dry air deposition and precipitation
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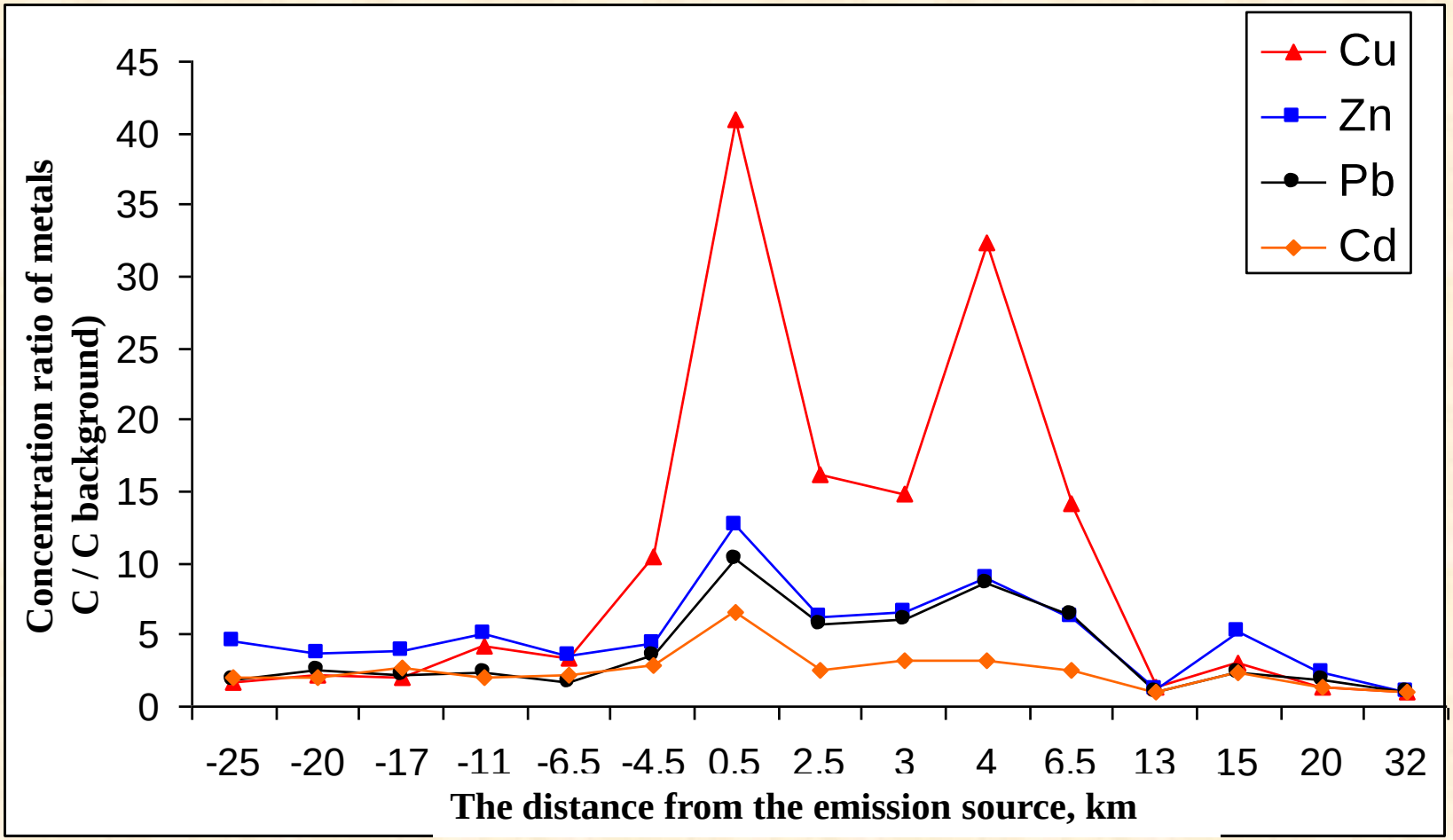
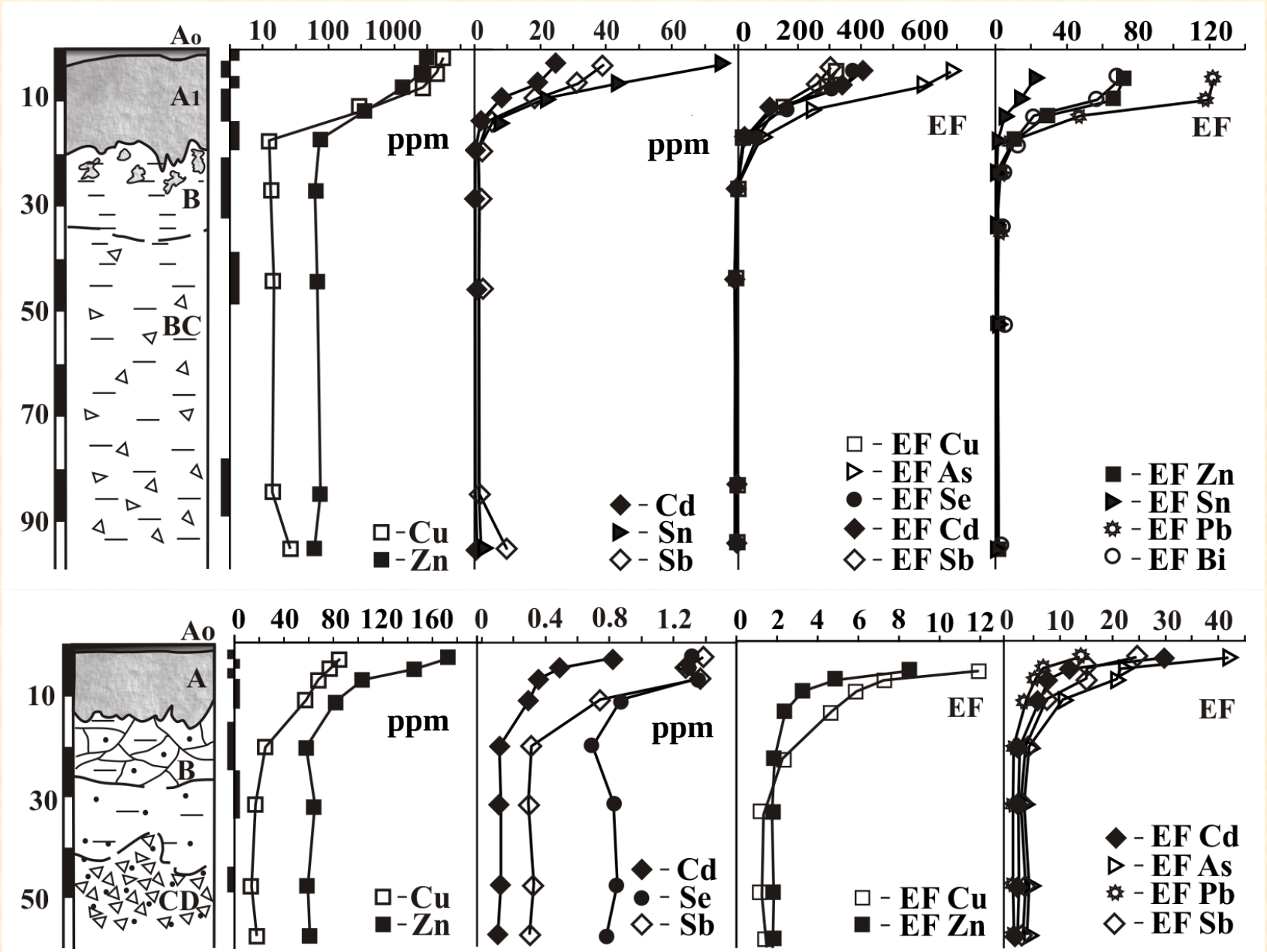
A₀
A
B
G
Root uptake
Surface flow
Soil water flow
River transport
Fixation in biocomplex
Transferring by suspension
Consolidation in sediment

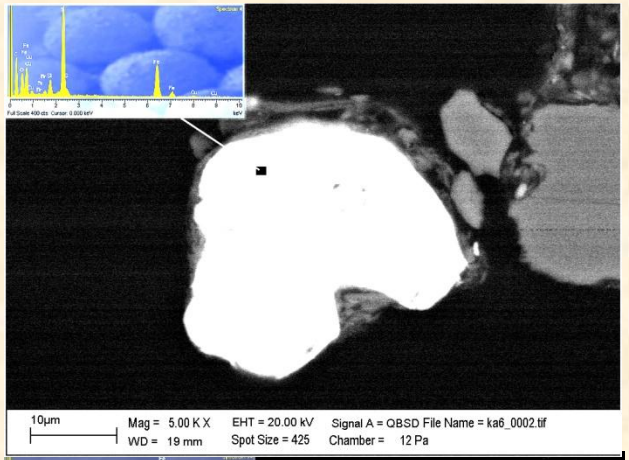
The dependence of metal accumulation in soils on the distance from the emission source

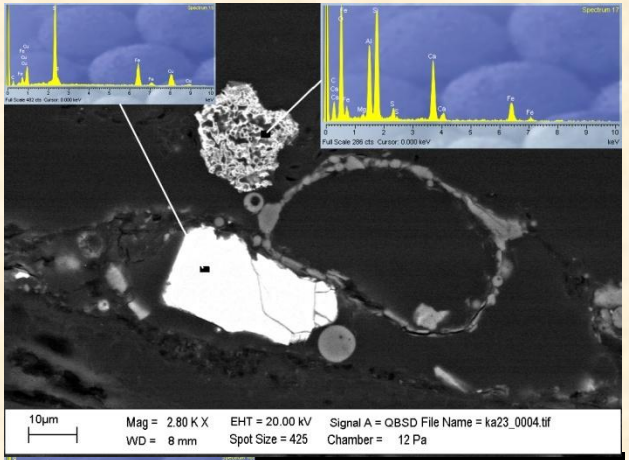


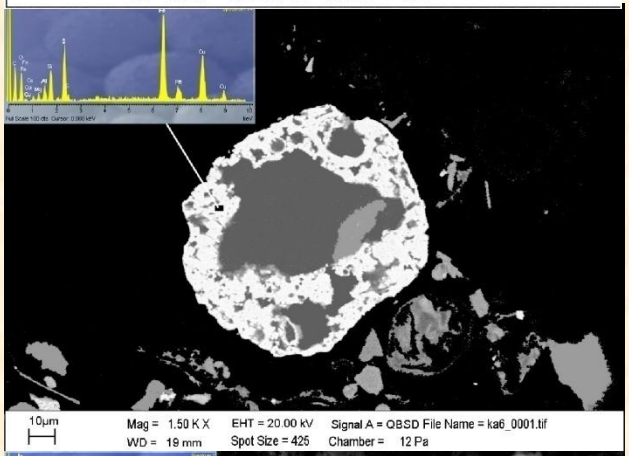


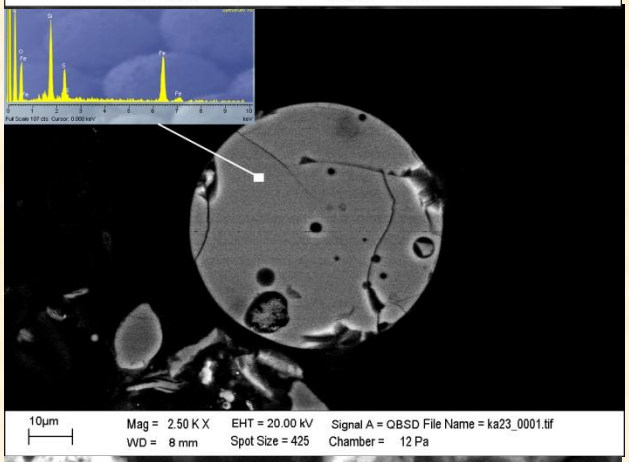
Vertical distribution of chalcophile elements and enrichment factor (EF) in the soil profile at 2 km and 51 km upwind of the emission source

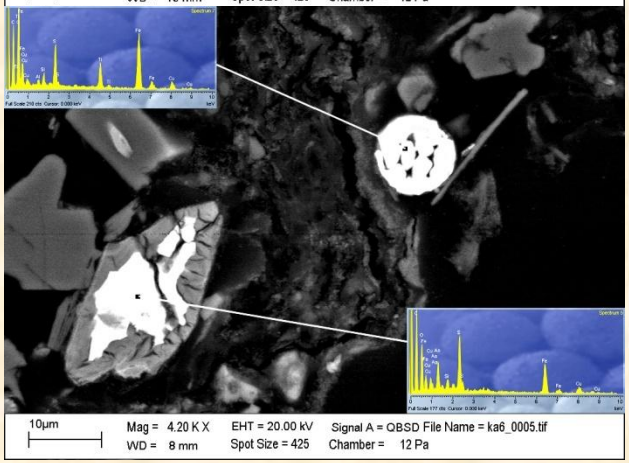
Mineral particles in soils

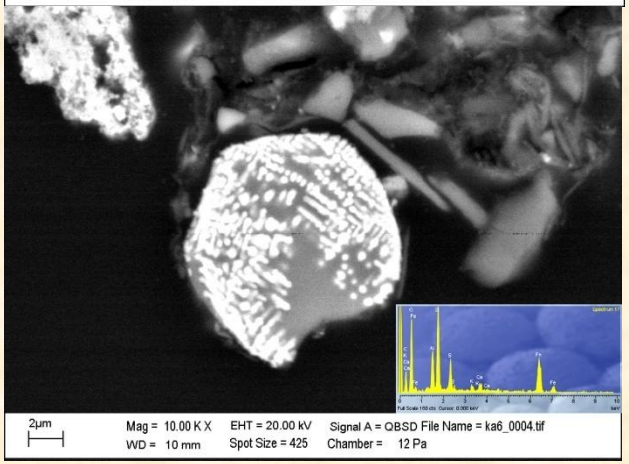


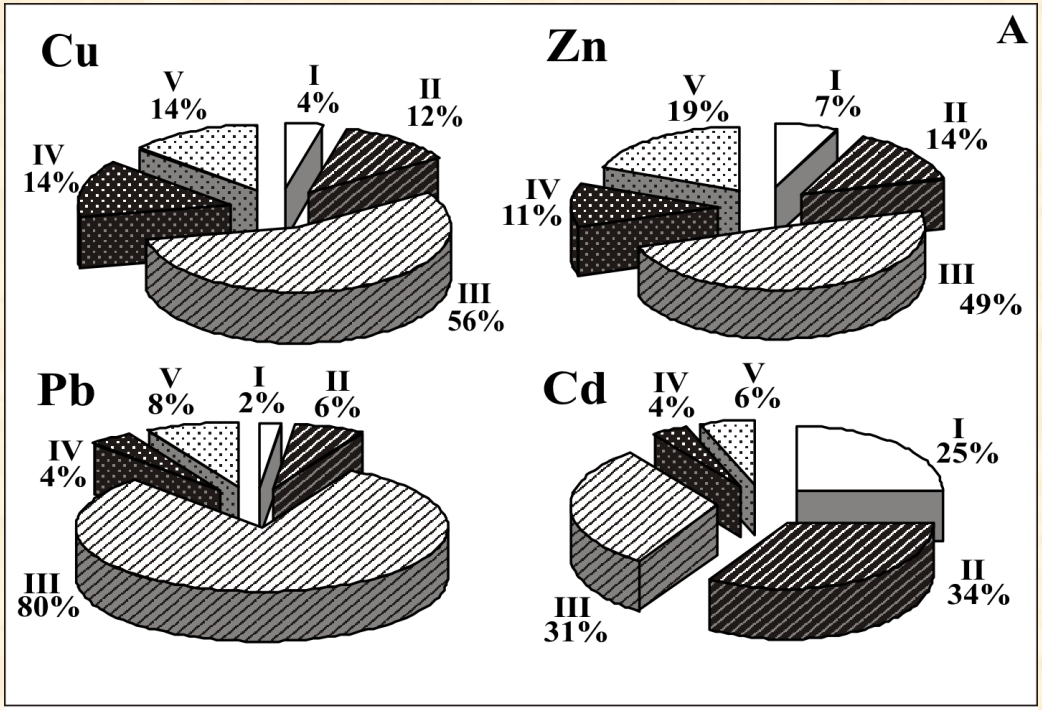


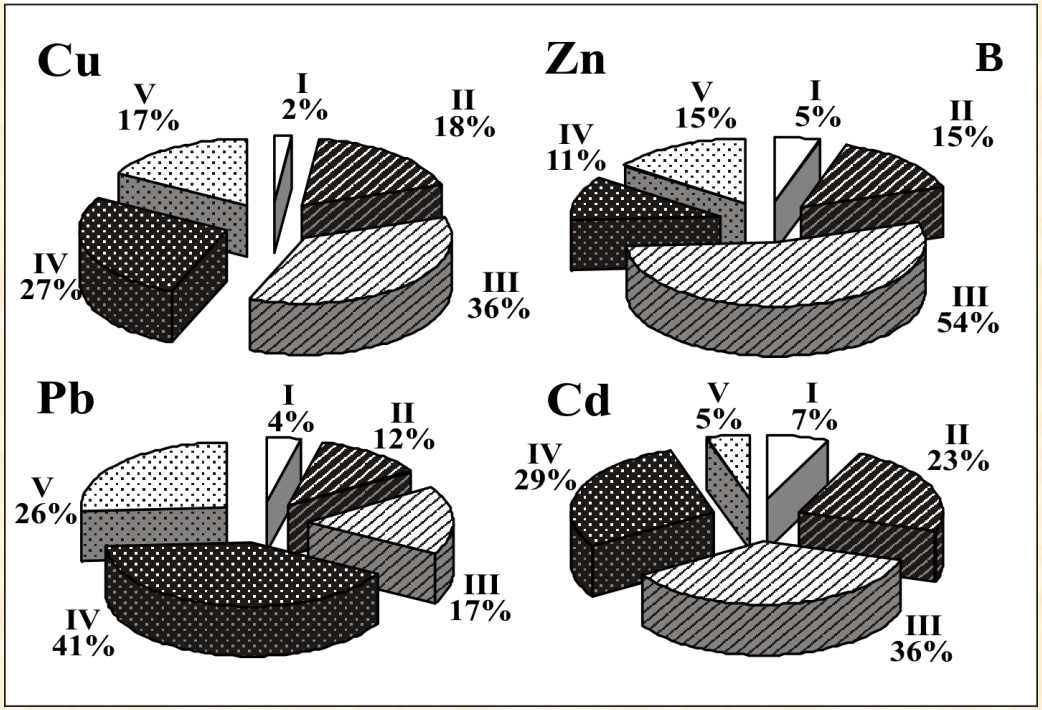












Forms of heavy metals in two contrasting soil types (A – Karabash, B – Mednogorsk).

Forms:

I – exchange;

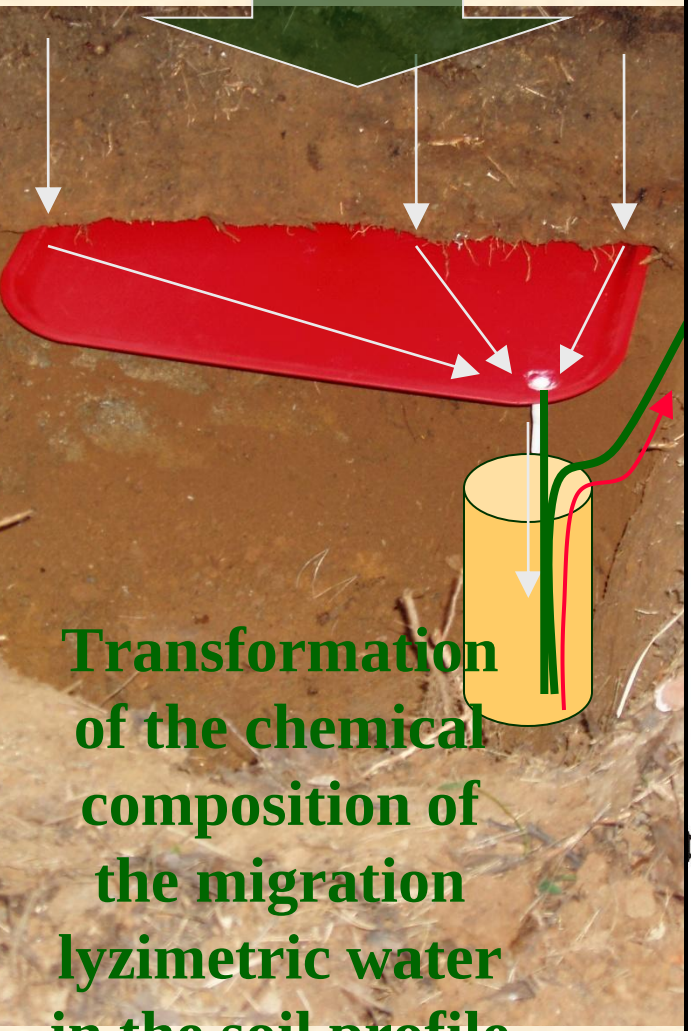
II – with carbonates;

III – with hydroxide Fe and Mn;

IV – with organics;

V – «silicate»

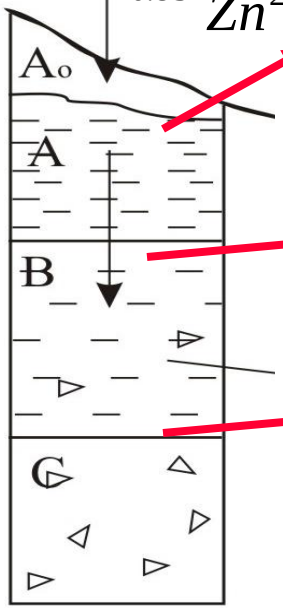
Precipitation, have passed through the soil



Transformation of the chemical composition of the migration lyzimetric water in the soil profile

$$M_{0.27}\frac{SO_4^{2-}95.8Cl^{-}4.2}{Zn^{2+}77.8Cu^{2+}13.8Ca^{2+}8.4}3.67$$

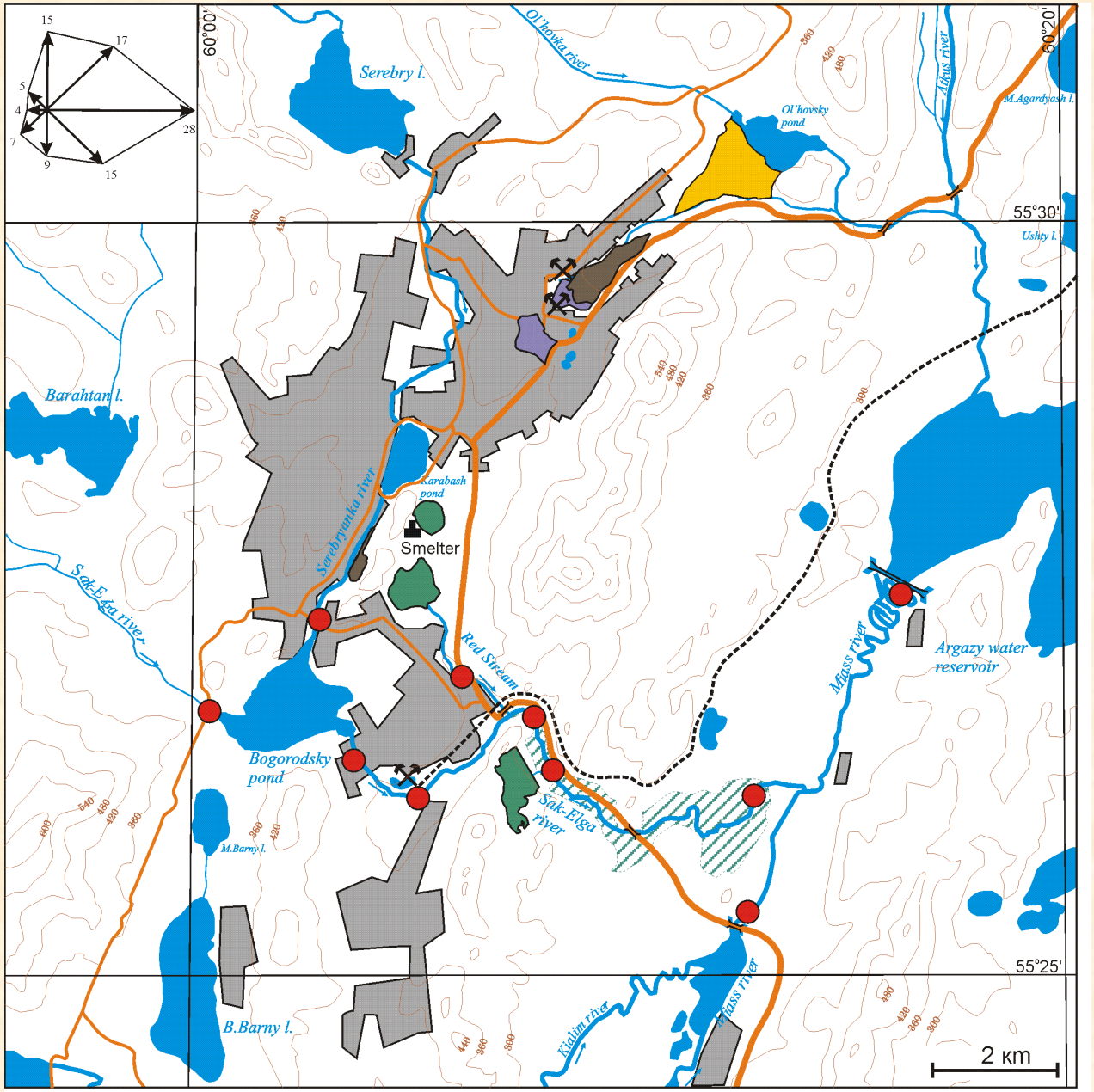
$$M_{0.85}\frac{SO_4^{2-}95.0Cl^{-}5.0}{Zn^{2+}43.2Al^{3+}27.9Cu^{2+}20.9Mg^{2+}8.0}3.6$$



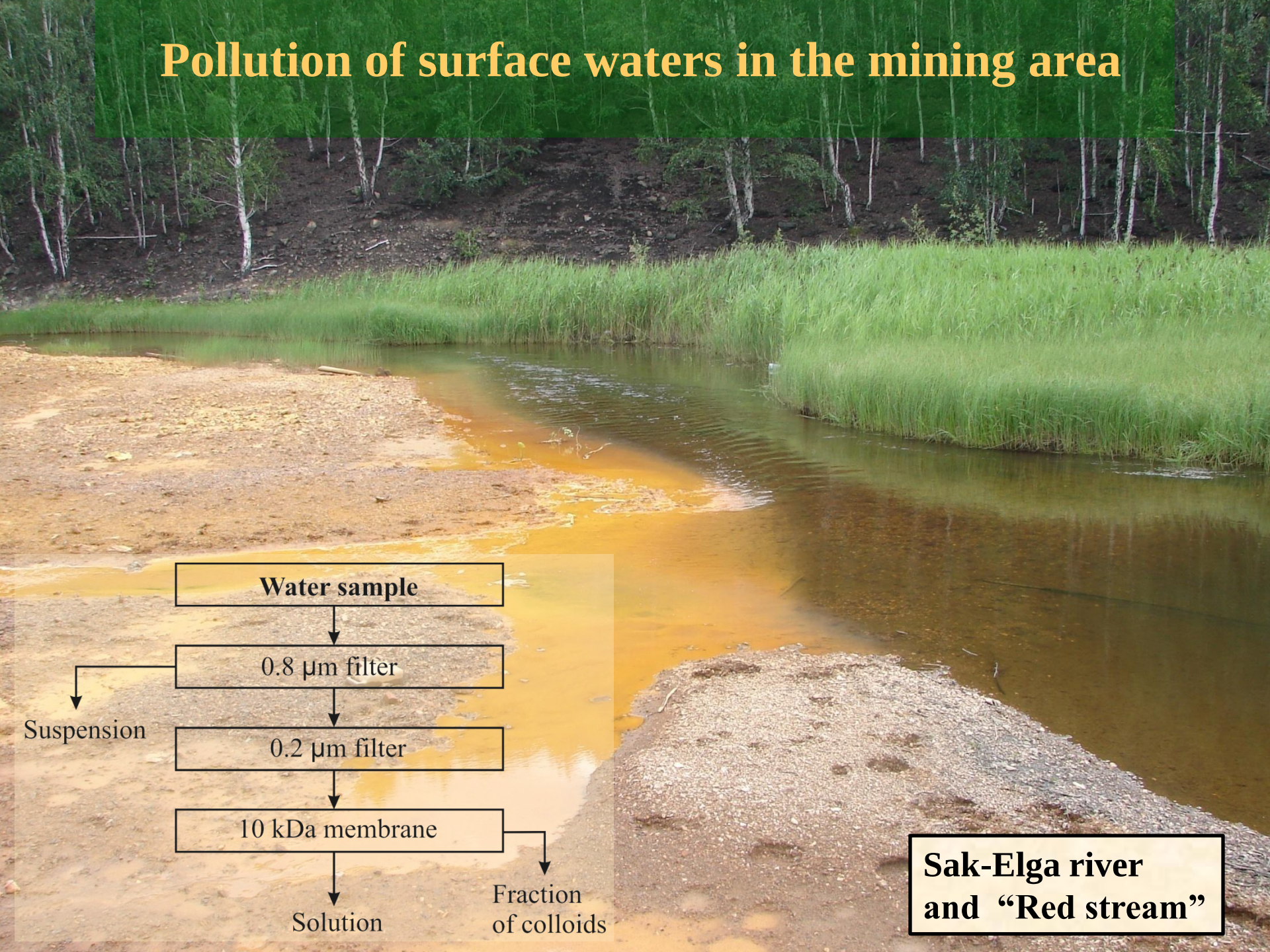
$$M_{1.16}\frac{SO_4^{2-}96.0Cl^{-}4.0}{Mg^{2+}51.0Ca^{2+}49.0}5.70$$

$$M_{0.88}\frac{SO_4^{2-}100.0}{Mg^{2+}80.7Ca^{2+}19.3}6.80$$

Serpentinites

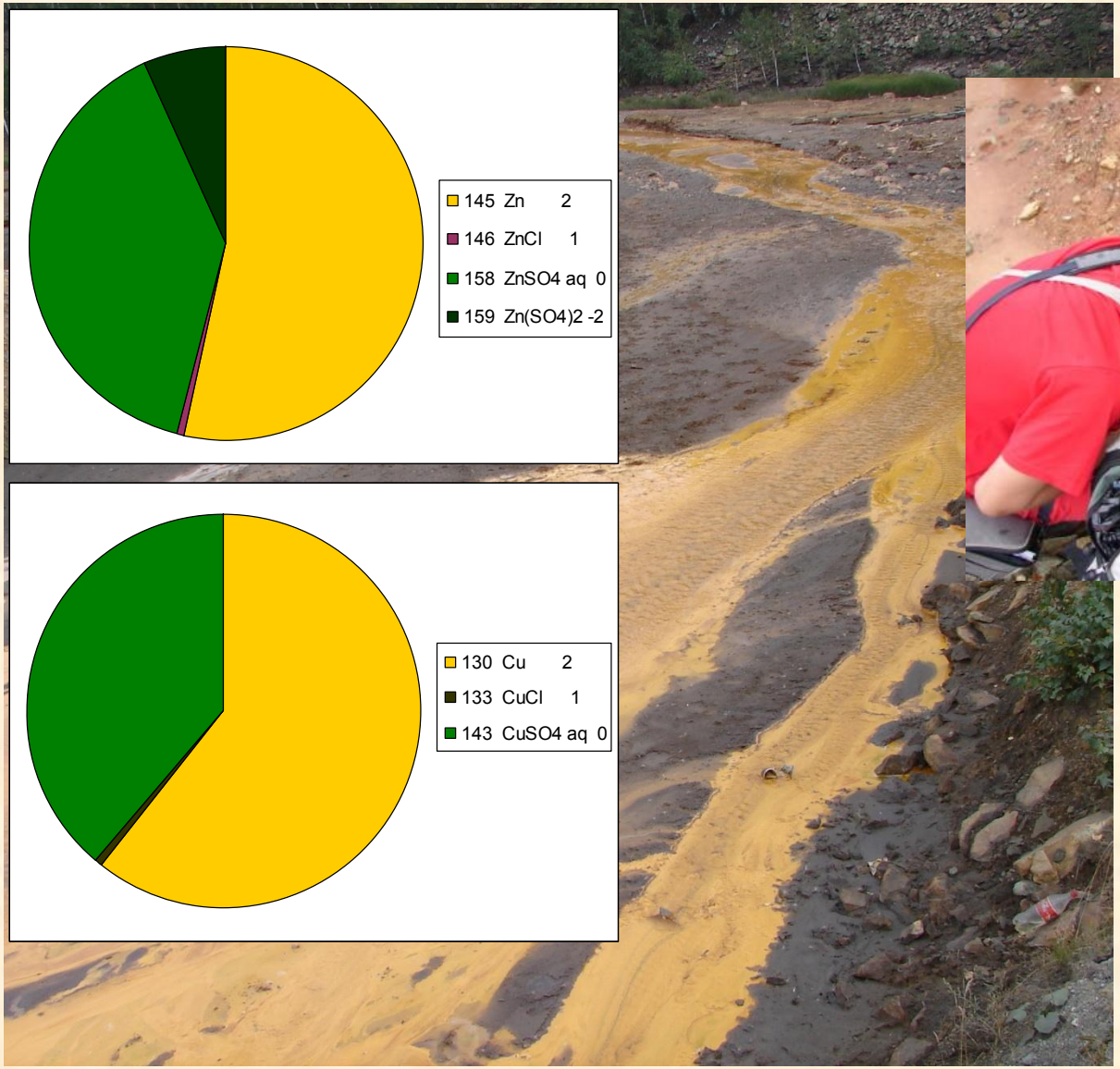

15
17
5
4
7
28
9
15
60°00'
60°20'
55°30'
55°25'
Serebry l.
Ol'hovka river
Ol'hovsky pond
Atkus river
M.Agardyash l.
Ushty l.
Barahtan l.
Karabash pond
Smelter
Serebryanka river
Sak-Elga river
Red Stream
Bogorodsky pond
M.Barny l.
B.Barny l.
Miass river
Argazy water reservoir
Kiallim river
2 km
Karabash town
Tailing
Washout from tailing
Waste rocks
Road
Railroad
Metallurgical slags
Mine
Iron hydroxide sediment

Pollution of surface waters in the mining area



Sak-Elga river and "Red stream"

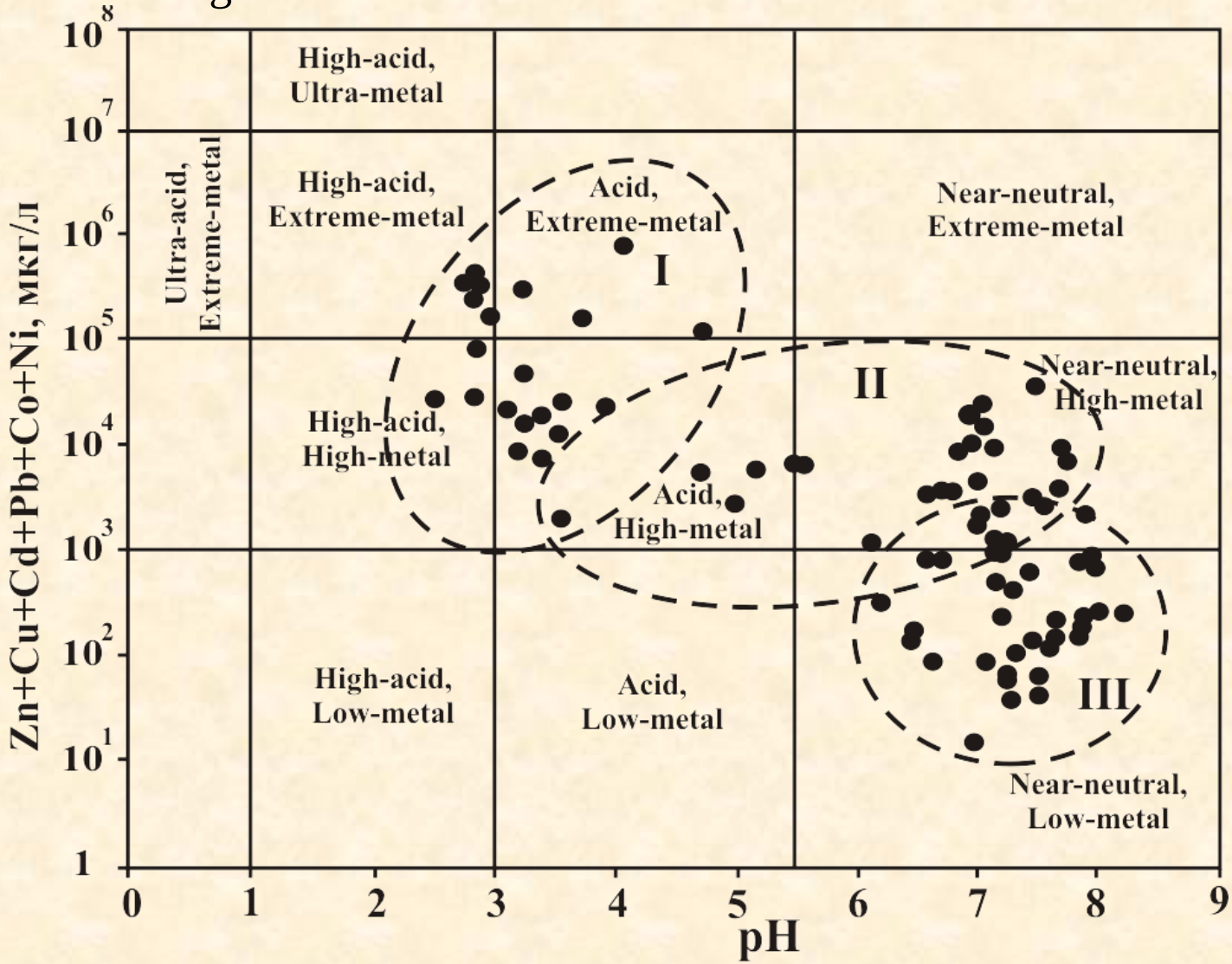
Technogenic streams



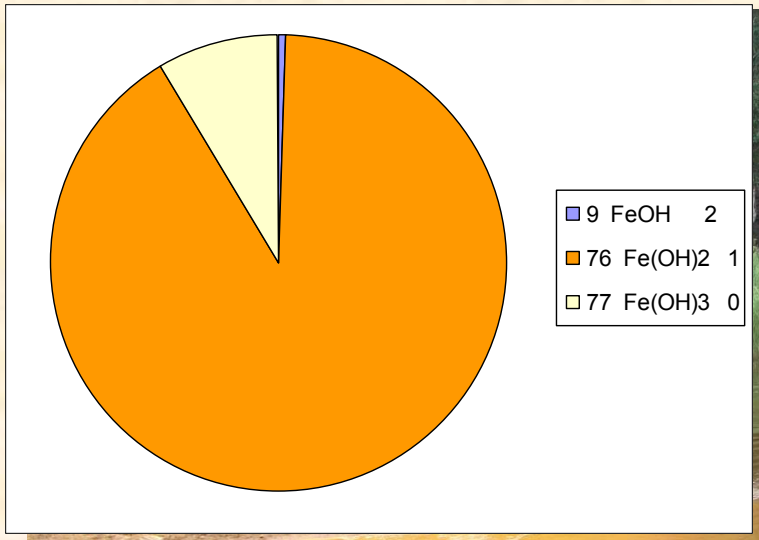
pH – 2.7-2.9
Cu – 20-50 ppm
Zn – 60-80 ppm
Al- 40-50 ppm

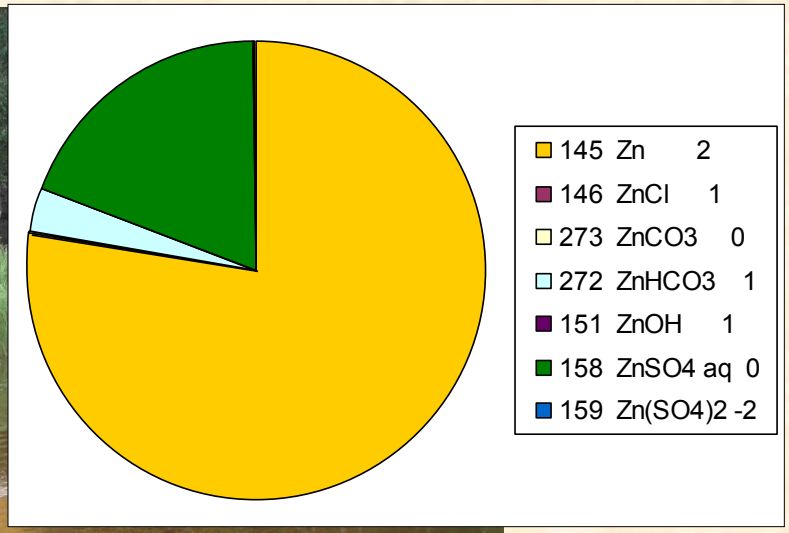
Classification diagram of water geotechnical systems of the Southern Urals and background areas

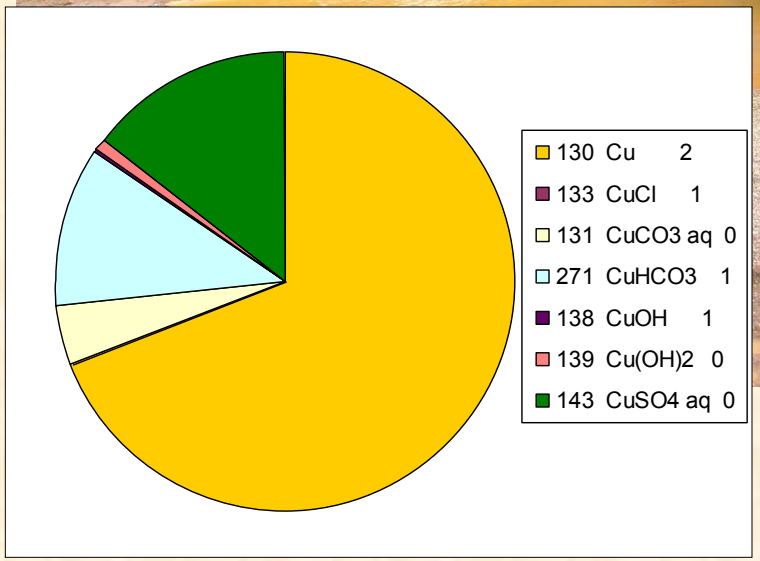
I – Ultra-acid technogenic water, II - the water of mixing zones,
III - Neutral background water .



Watercourses in the mixing zones

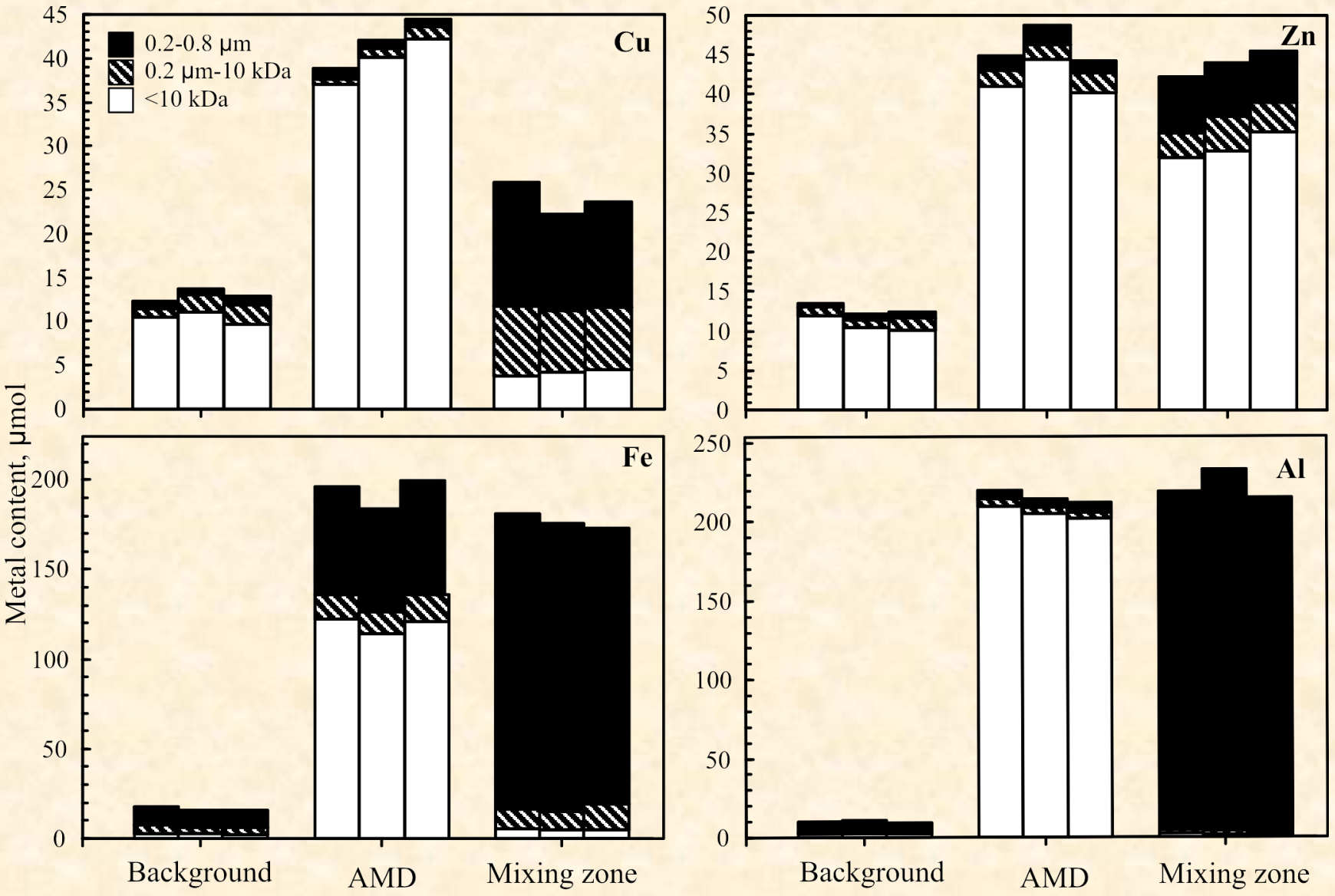




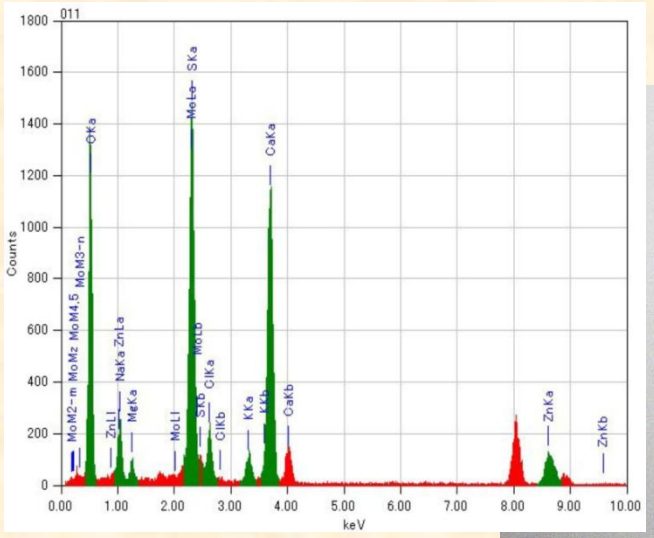


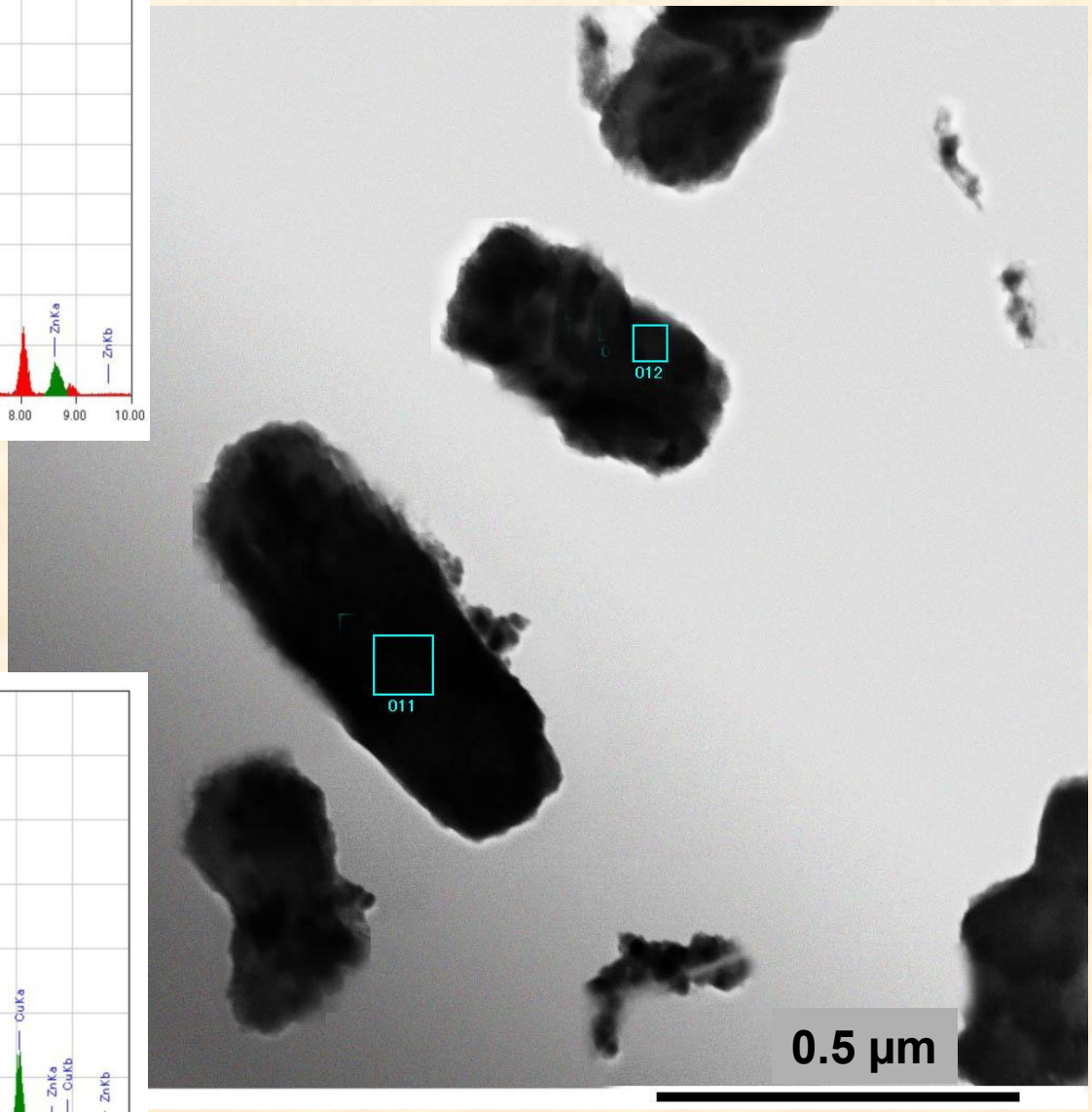
pH – 3.3-5.9
Cu – 4-10 ppm
Zn – 10-15 ppm
Al- 10-15 ppm

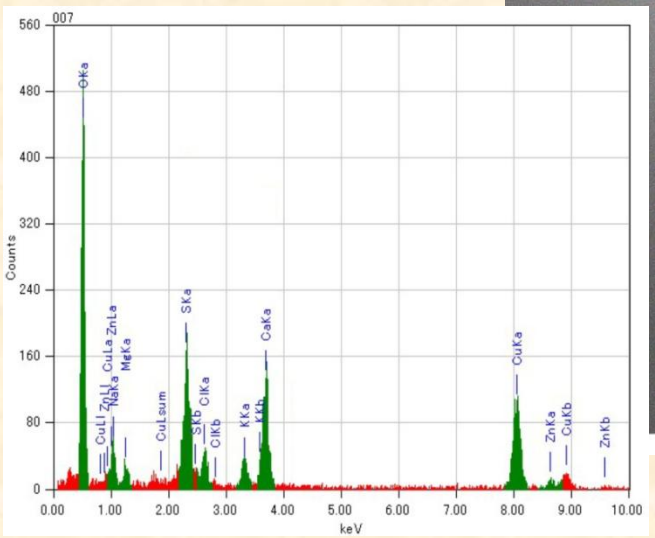
Migration forms of heavy metals in AMD



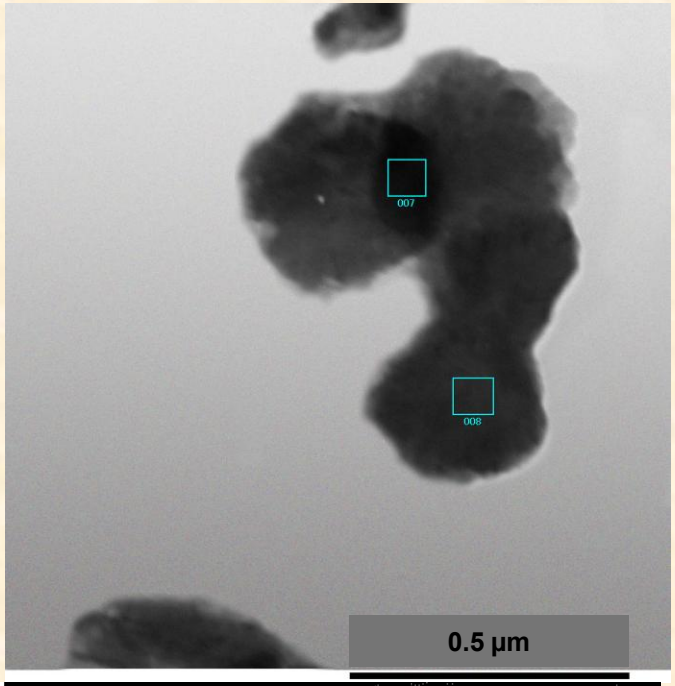
Particules of colloid fraction in AMD

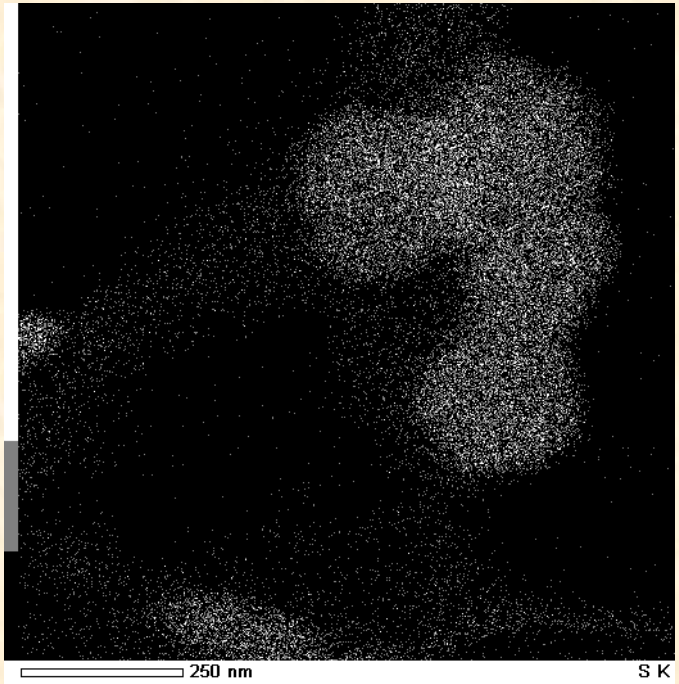


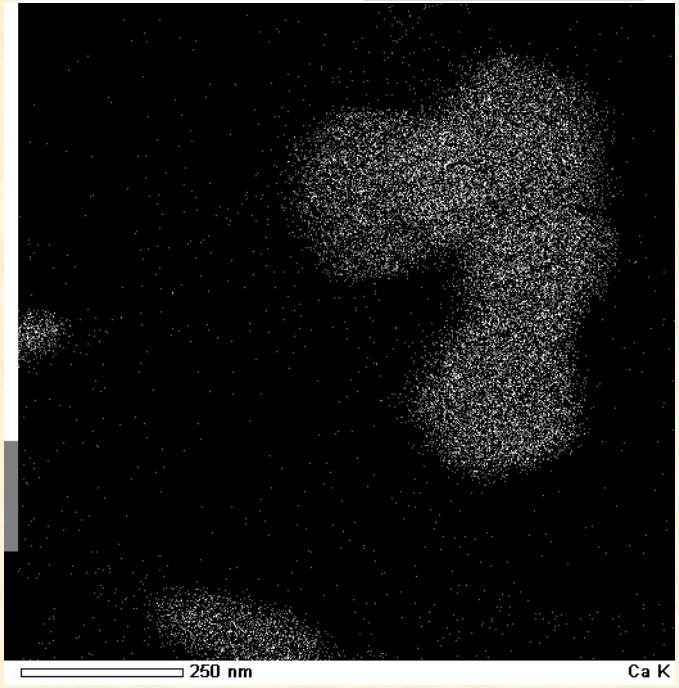


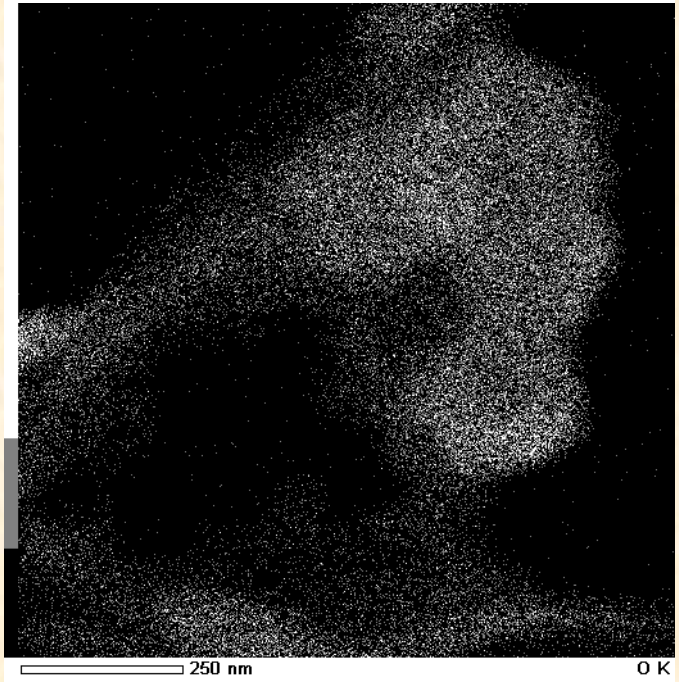


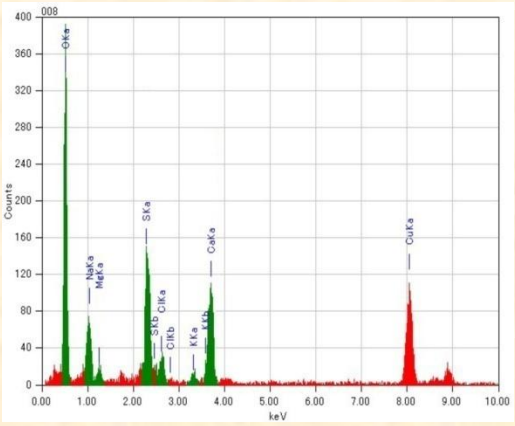
Colloid particles in AMD



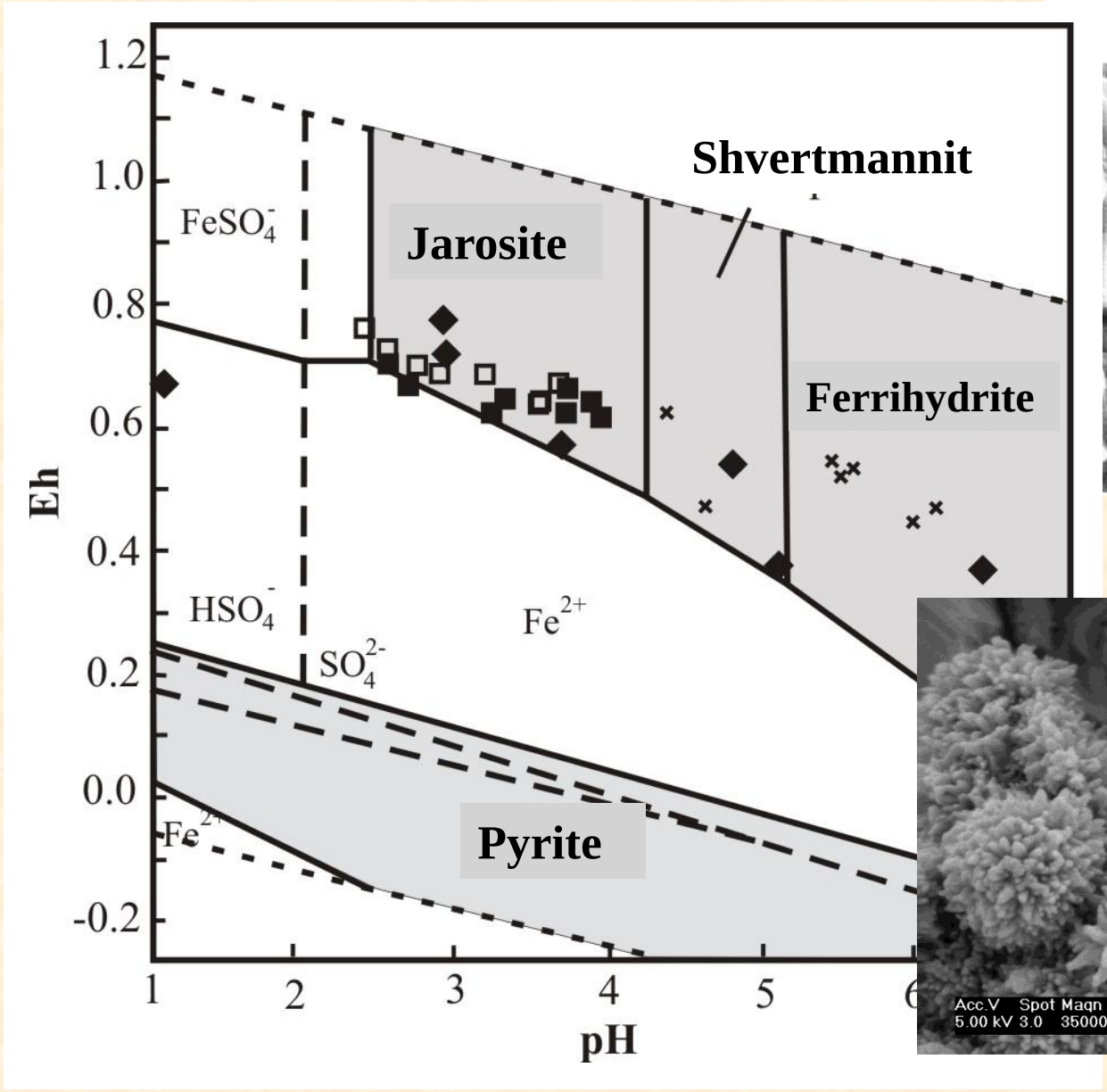


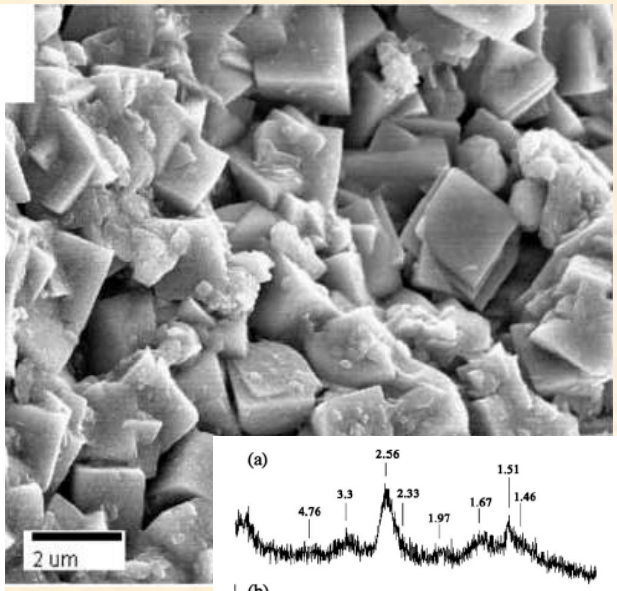


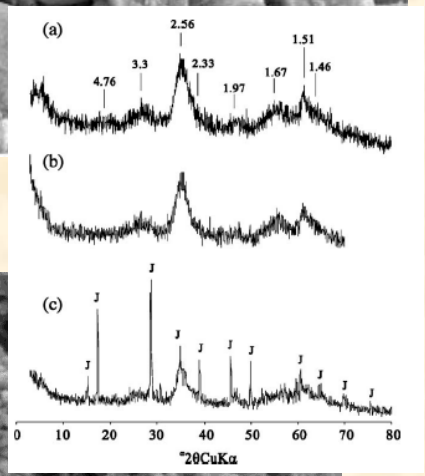


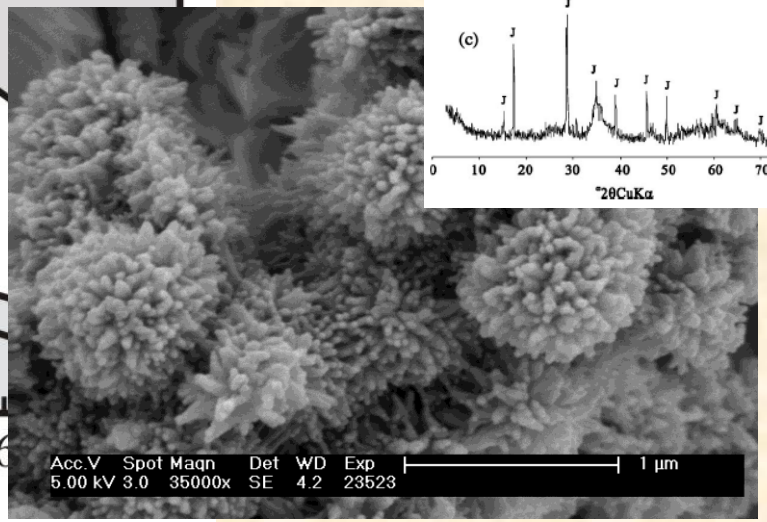


New authigenic mineralisation in AMD









Ground-mineralogical and geochemical study of mining waste and pollution processes




Thank you for your attention!