Actual knowldge on national and international level

Contamination of soil with heavy metals and assessment of potential risk on living organisms represent one of the most complex tasks of the today specialists. This is caused, one hand, by the complexity of microbiological and physico-chemically processes which control the type of chemical combinations in soil, and on the other hand by the difficulties associated with toxicity assessment which implies the establishing the bio-availability of heavy metals level in soil. The project intends to be a answer to challenge to reduce on long term the pollution caused by mining industry (Romania) and uranium industry (South Africa), especially of acid mine drainage which favorized the dispersion of heavy metals in environment.

The zeolit, the microorganism and the vegetal species are widely used for reducing of pollutant from fluid, solid and wastes. There are many experimental studies about utilization of zeolits, microorganism and vegetal species for eco-remediation of soils polluted with heavy metals and cyanides, but many of them study only binary systems: gangue-zeolit, gangue-microorganism, gangue-vegetal species. Further we present some characteristics aspects:

Sistemul steril-zeoliti

Among the processes used for extraction of pollutants from liquide phase (mining drainaje) we can mention: ion exchange, precipitation, organic complexation, and reverse osmosis. Of these, ion exchange is preferred since low-cost ion exchangers can be used. Soils are effective agents for metal sorption owing to their high specific surface area and the presence of various functional groups that enhance adsorption. Components such as iron, aluminium, and manganese oxides and hydroxides, clay content and organic matter fractions are regarded as the main controls for heavy metal sorption (Tessier et al., 1985; Davis, 1984). Solution composition, which influences the complexation and speciation of metals in solution, will also affect the attenuation of heavy metals in soils (Vuceta and Morgan, 1978). Clay and organic materials (natural and man-made) are being used as metal-adsorbents nowadays, depending on the nature of the application. Natural zeolites, for instance, are gaining significance in adsorption studies owing to their sorption characteristics as well as their structure (molecular-sieve type) which can be modified with relative ease (Sprynskyy et al., 2006). Zeolitic structure having pores through network have the property for ionic exchange. At the contact with solution contain metalic cations, these will replace mono and bivalent cations existing in the pores of aluminosilicates structure by a similar reaction of ionic exchange. Numerous studies (*Ouki* *and Kavannagh, 1999; Malliou et al., 1994; Erdem et al., 2004; Inglezakis and Grigoropoulou, 2001; Babel and Kurniawan, 2003*) present various aspects regarding the removal of metals from wastewaters or from synthetic solutions by using clynoptilolite of others zeolites, to their utilisation as amendments for rehabilitation of polluted soils.

Gangue-vegetal species system

All researchers are agree that plants change the chemistry of rizosphera-soil interface, the principal cause being the organic secretions of roots (aminoacids, zaharides, organic acids, etc.) which stimulate the microbial activity in rizospehera due to increase of carbon content (Francis et al. 1992). These secretions increase the solubility of heavy metals in soil acting like chelating agents which form with heavy metals soluble compounds adsorbed by the roots and transported in the plant (Figure 19) (Naidu R. et al. 1998), or, easily replace ions from soil solution. Content of heavy metals bio-accumulated in plants, bio-accumulation pathways and mechanisms are mainly influenced by: soil characteristics (pH, redox potential, porosity, hydraulic conductivity, strength of metal-soil bonds, etc.), types of plants cultivated (ex: salad bio-accumulates especially Cd) (Brown et al. 1996), soil microbiota (*Pseudomonas, Bacillus*) and soil microfauna (protozoars, nematodes, etc.) (Giller et al. 1997). Intensity of bioaccumulation and transport's processes depend by the nature of metal and bio-chemical reactions it takes part in, especially by its capacity to interact and to form combinations with the compounds presented in plant's sap. As example, we can mention negative charge complexes resulting due copper and plant's sep interactions, followed by the lowering of cell wall' permeability thus being stimulating the ascendant transport of copper in plant. In lead situation, the formed complexes are adsorbed on the cell's wall and the transport is decreased. The mechanisms which allow translocation and bioaccumulation of heavy metals in plants are not completely understood, the toxicity of heavy metals being directly involved in plant's oxidative stress inducing. Ea example, we can mention that even we know that Cd is blocked in plant in small chains peptides-complexes (phytochelatates) and with the sulphures, is not completely understood what is happened with the metals after the mention compounds are formed and what how is metal mobilized in and among the plants' tissues. Lakes exists also in assessment process of heavy metals contaminated food's impact on human's organism (interferences in bio-chemical processes al cell level, disfunctionalities provoked) (Sheppard 1995, Bachmann 2006)

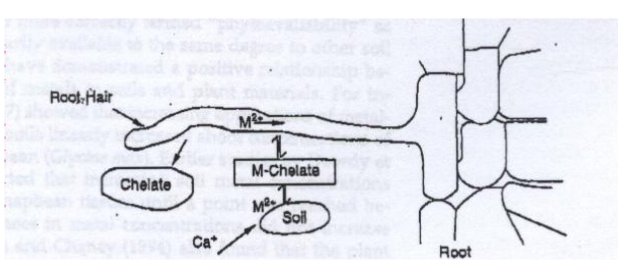

Figure 19. Mechanism of heavy metals release from soil and their adsorbtion by plant's root

Zeolit-microorganisms-vegetal species system

Zeolites are non-toxic and obtainable in most countries, although generally considered too expensive for bulk applications in Africa. Additionally, the mineral stability of zeolites and their structural changes under treatment in various media play important roles in their potential utilisation as ion exchangers.

The combination of charged sieve architecture (zeolites) with highly charged microbial biomass (chitin and polysaccharide wall-components) can be expected to enhance metal and radionuclide capture from solutions. Increases of adsorbtion capacities of zeolites can be made by using them as support for biomass (fungus, microalgaes and cyanobacteria), recognized as having a large capacity for binding of pollutant ions during as different passive and active interactions with cell walls or with extracell zacharides. Practical utilisation of these microorganism is conditioned by their introducing in pollutant layer, by their tolerance to environment and (in case the recovery of metals is desired) by their collection from sublayer.

Because of large internal surface available for microorganisms with hyphals network, porous zeolites are used for commercial production of mucorrhizal fungus or as support medium for fungus or microalgae with high capacity for metal binding cultivation. The presence of biomass fungus/microalgae in the internal structure of zeolites give them the capacity to bind the metals in conditions that usually destroy unprotected cells and that allows to insert the system zeolit-biomass system in acid mine drainaje and concentration of metals in so called „biophysic packages". Binding capacity is increased by the presence in the zeolites of carbon sources (sterilized biomass). Metal-biomass connection being reversible according to the pH, the metals can be recovered. The methods can be applied in cases of extremely toxic systems, with high concentrations of heavy metals and cyanides, as can be mentioned in cases of tailing ponds from Romanian and Soutf Africa gold-silver -uranifer industries. Moreover, this „intelligent biotechnology" allows recovery of precious metals from infiltration waters, drainaje from gold ponds or from wastewaters trateament plants. The combination zeolites-biomass improve the capacity of adsorbtion and blocking of radionuclides from solutions. Different experimental reports prove that the presence of fungus and microorganisms from contaminated soil with heavy metals increase of rate of vegetation rehabilitation and phito-stabilization of contaminated areas by increasing of lenght, biomass production, lenght of roots and reducing the stress caused by the presence of heavy metals (*Adams et.al.2007, Alberton 2007, Yamashita 2007).*

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