COMPOSITE CLAY SORBENTS FOR IMMOBILISATION OF BIOMOLECULES AND CELLS

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INTRODUCTION

Microbial and organic contamination is huge problem in dumpsites, former and active farmaceutical industrial sites as well as areas contaminated naturally. Pollution of soil and groundwater is induced by diffuse sources such as application of herbicides, pesticides, insecticides in agriculture, point sources, e.g., wastewater streams. Immobilization of biomolecules and cells in such polluted soil can be performed by in situ treatment technologies, and soil amendments as immobilization agents are potential solution of the problem. Modified clay sorbents have broad perspectives for immobilization of different pollutants as lead, zinc, copper and other heavy elements, oil products, PAHs and at last, but not the least, biomolecules, cells, organic matter as well. Performance of innovative sorbents for organic, microbial and medicine waste treatment from aqueous and disperse solid media is important as environmental clean-up industry demands material highly efficient, recyclable and sustainable.

Another application which should be studied in a more profound details is the investigation of best performance of modified clay if it is used as carrier of necessary medication (pharmaceuticals, biomolecules, antibiotics) in order to get direct impact to tissues and organs needed for treatment.

Clay properties can be significantly modified using different approaches to obtain materials with new areas of application. Considering highly hydrophilic properties of clay minerals, one of the major aims of such modification is their hydrophobization in order to improve interaction with low polarity organic molecules - a common group of materials in this respect are organoclays. However, intercalation and binding by ionic bonds of organic modifiers, does not prevent their leakage during application of such materials, especially if they have some degree of biological activity, toxicity.

The aim of our experiments was to steddy properties and feasibility of different organic and inorganic materials served as a carrier for immobilization/incapsulation of beneficial microorganisms and to develop methods of synthesis for clays modified chemically with different functional groups (graftpolimerization).

RESULTS & DISCUSSION

Clay sorbents modified with iron oxyhydroxide (amorphous phases) and hydroxylapathite achieved improved beneficial properties for specific applications crucial for improved sorption as cation and anion exchangers. It revealed broader perspectives for the further investigation of materials in order to use for immobilization and encapsulation of specific organic type substances capable to be sorbed on increased surface area.

Graftpolymerization by polymerization of acrylic (methacrylic) acid derivatives with radical initiation onto clay surface helps to cover clay surface with a layer of polymeric chains, thus significantly changing the properties of the obtained materials.

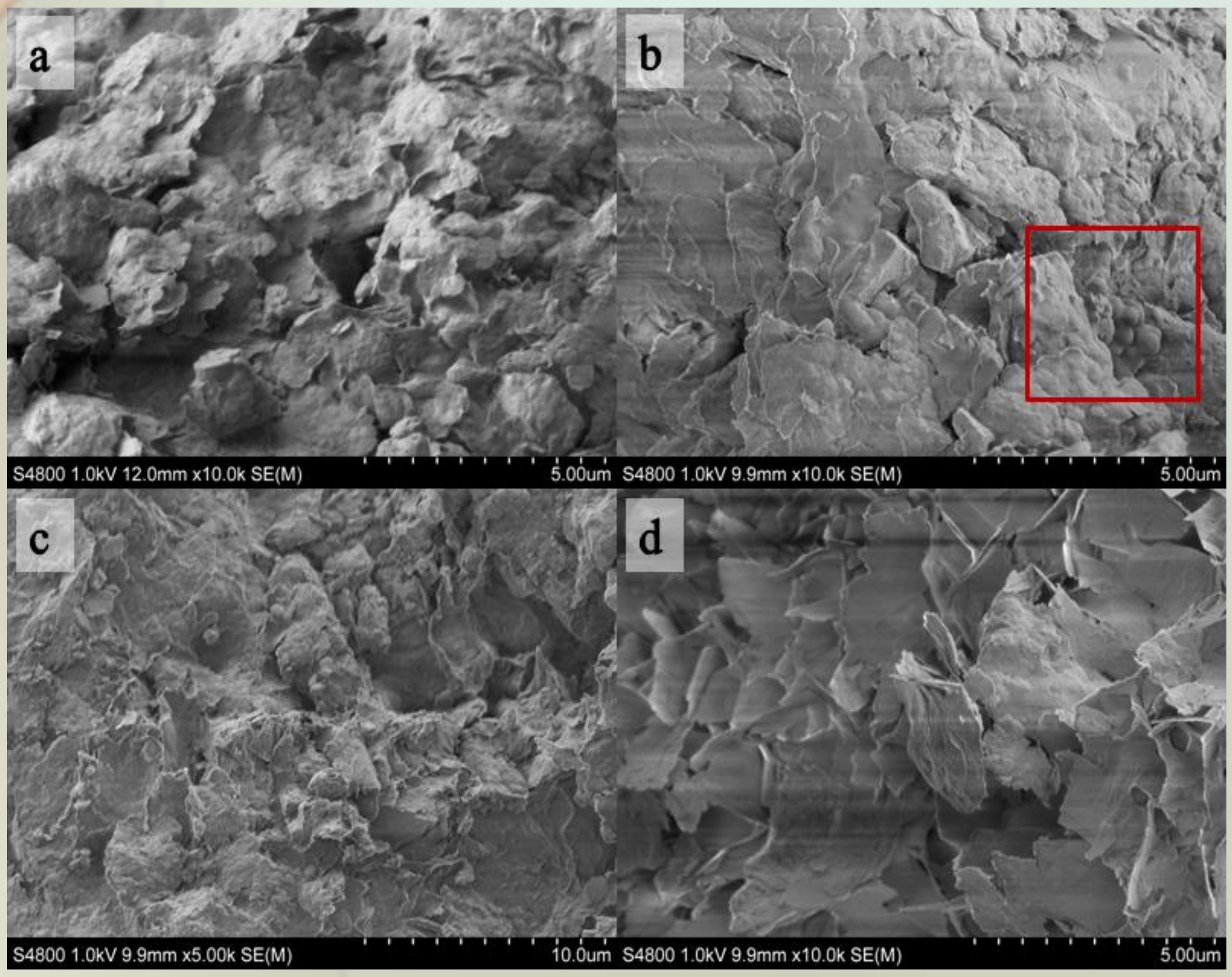


Fig.4.The comparison of SEM images for : a) raw Triassic clay and modified with b) sylanes-APTES; c) Fe oxyhydroxide; d) hydroxylapathite Ca/P 1.67

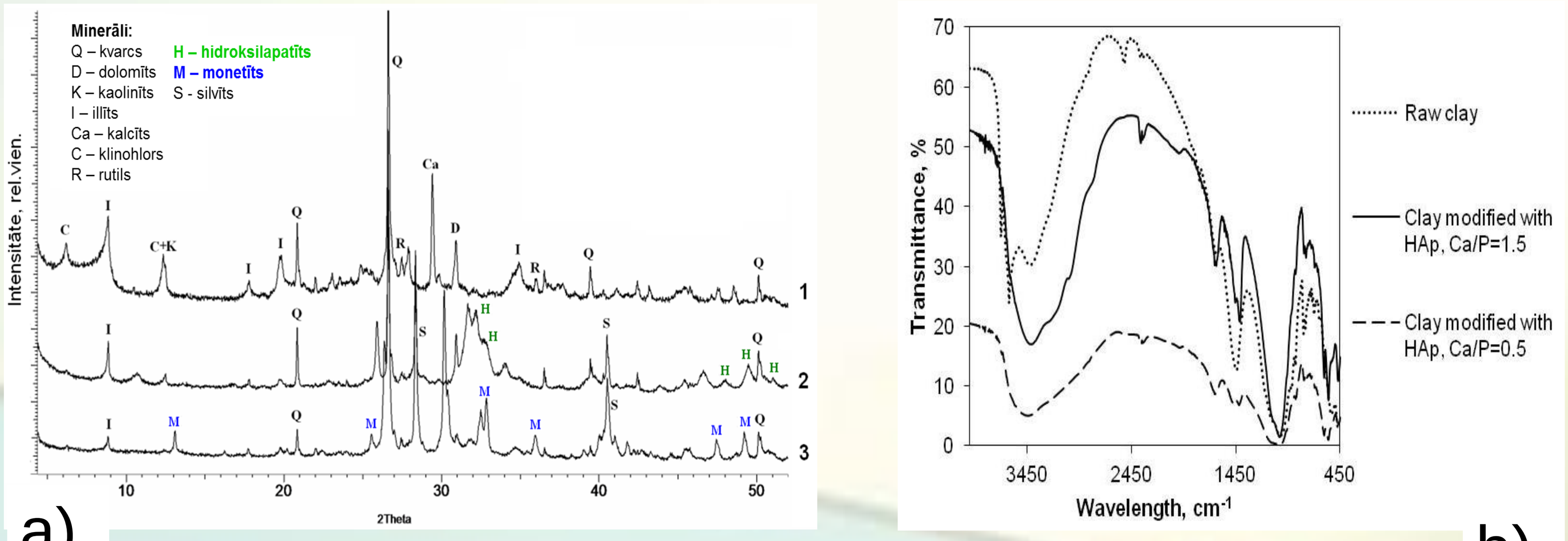
CONCLUSIONS

Clay sorbents modified with iron oxyhydroxide and oxyapathite achieved improved beneficial properties for specific remedial applications regarding heavy metals and metalloids. This type of sorption properties can be used for immobilization of inorganic toxic material produced by microorganisms. Organoclays with sylanes modified on (in between layers) of montmorillonite with its introduced functional groups are able to interact with organic molecules of differing polarity and thus serve as immobilizers for organic molecules and toxicants as well as possibly serve as carrier of medication (pharmaceuticals, biomolecules, antibiotics) to tissues and organs.

MATERIALS & METHODS

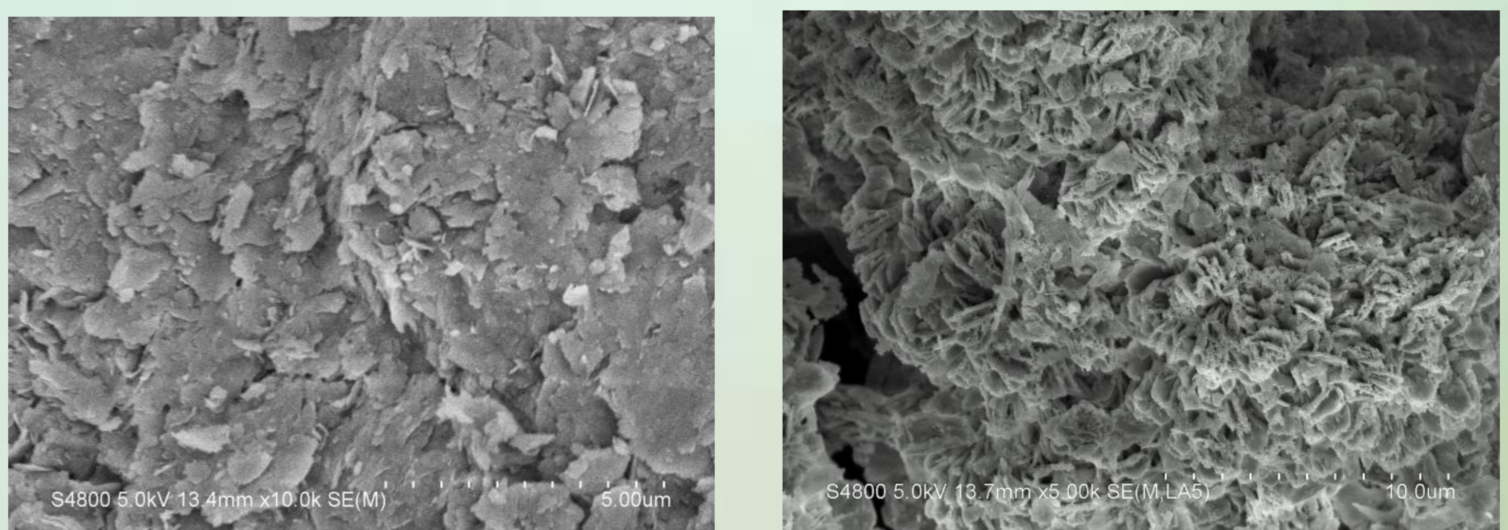
Series of metal speciation and immobilization efficiency experiments were performed for natural and synthetic modified clays by adding in one case amorphous iron oxyhydroxides and in another - monopotassium phosphate and calcium chloride. Innovative materials were characterized using texture analysis, PXRD mineralogical analysis, SEM images, BET surface area determined and FTIR spectra obtained, sorption pattern determined and amount of exchangeable fraction for immobilized metals determined.

Chemical modification also were done with derivatives of trimethoxysilanes, containing, for example, aminopropyl -, glycidyl- or thiol- functional groups. Reaction is fast, and it ensures possibilities to obtain materials with a high derivatization degree, but the desired functional groups are attached to the surface of clay minerals with covalent bonds



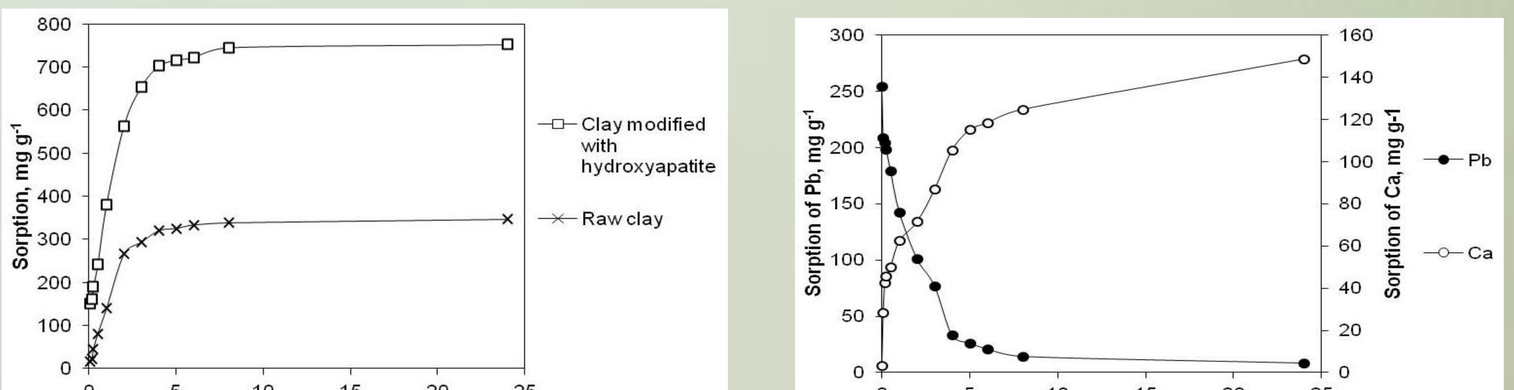
a) b)

Fig.1. a) PXRD and b) FTIR patterns for hydroxylapathite modified clay



a) b)

Fig.2. The surface of a) raw and b) HAp modified Lielauce clay sample in 0.5 Ca/P equimolar proportion (monetite)



a) b)

Fig.3. Hydroxylapathite sorption on cationic exchange basis: a) efficiency for model contaminant Pb; b) Ca and Pb exchange reaction during sorption kinetics experiment for contaminated with Pb solution

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