Vitrified waste: route for the future?

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Context of the study

With regard to its policy, the SAEFL explores new routes for redirecting residues of municipal solid waste incineration. High temperature vitrification is one of the potential alternatives for waste management of tomorrow.

In that respect, the SAEFL initiated a broad survey of the characteristics, behaviour and long-term durability of 23 high temperature materials originating from 16 different processes developed by 10 Swiss, German and French companies.

The signature of high temperature materials

The characteristics of samples (vitreous or vitrocrystalline state, specific surface area, composition) are not related to their parent process. SiO_2, Al_2O_3, Fe_2O_3, CaO dominate the composition and sum up to 82-93% ($[SiO_2+Al_2O_3]$:[CaO]= 1.2-5.9). The total toxic metal content may reach 2.5%.

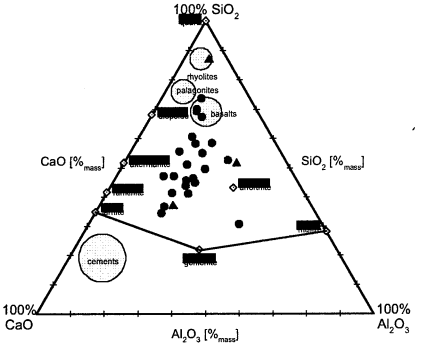

Figure 1: SiO_2-CaO-Al_2O_3 diagram showing the broad range in compositions of products from the high temperature incineration of municipal solid wastes and their residues.

Matrix dissolution during accelerated batch corrosion tests is not congruent. It is governed by CaO but rapidly decreases to limited values due to the formation of secondary minerals. SiO_2-rich/CaO-poor samples behave on better terms, and leaching of toxic metals never exceeds 100µg/L.

The long-term durability of samples, estimated from thermodynamic calculations, is comprised between the ones of medieval glasses ($<10^3$a) and of nuclear high level waste glasses ($>10^4$a). SiO_2-Al_2O_3-rich/CaO-MgO-poor samples exhibit higher thermodynamic stabilities.

Altogether, the characteristics of high temperature materials favour their long-term stability toward corrosion. These results address the relevance of the actual Swiss guidelines, which were not designed for such materials.

References

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Biogeochemical behaviour of americium in the rhizosphere

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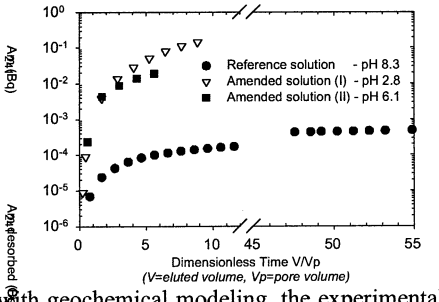
This study investigates the major processes controlling americium biogeochemical speciation in the rhizosphere of agricultural soils. The main objectives are to quantify and model influence of the physico-chemical parameters of soil and soil solution as well as the potential role of microorganisms on the mobility of americium.

Lixiviation tests are performed on columns packed with a 2mm-sieved calcareous soil contaminated with ^{241}Am, under steady-state unsaturated or saturated hydric flow. The columns are percolated with soil solution of varied composition (pH, ionic force), spiked with citric acid and/or glucose (taken as models of root exudates), either in sterile and non sterile conditions. The physico-chemical parameters of the outlet solution (pH, conductivity, major ions, organic acids) are monitored, as well as the microbial activity. Inorganic and organic semi-quantitative speciation of ^{241}Am is given by a size/_ activity/organic carbon relationship obtained by ultrafiltration. Complementary experiments in closed systems (batch) give precisions both on sorption /desorption processes and their kinetics, and on microbial dynamics (biomass, activity, diversity of colonies).

The first results in saturated columns show that a combination of citric acid (I) or Na-citrate (II) and glucose at 0.01 M (amended solution) leaches a thousand time more ^{241}Am than the soil solution in equilibrium with the soil (reference solution) (cf. figure). Enhanced complexation, colloidal transport and microbial activity are likely the processes involved.



Coupled with geochemical modeling, the experimental results will define the key factors controlling the speciation of americium in the rhizosphere.

References

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