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Topics:
Solid wastes
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Leachates
Water quality
Mathematical models

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Geochemical Behavior of Chromium Species

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REPORT SUMMARY

SUBJECTS	Solid-waste studies / Solid by-product disposal/reuse / Water quality/aquatic resources / Water quality control
TOPICS	Solid wastes, Groundwater, Chromium, Leachates, Water quality, Mathematical models
AUDIENCE	Environmental and R&D scientists and engineers

Geochemical Behavior of Chromium Species

New mechanistic data can help utilities predict the geochemical behavior of chromium from solid-waste disposal sites. These data indicate that precipitation reactions would keep chromium concentrations in most groundwater at safe levels.

BACKGROUND Comprehensive data on interactions between chemicals dissolved in groundwater and porous soil materials are essential to accurately predict the migration of chemicals from utility solid-waste disposal sites. As part of its ongoing solid-waste environmental studies project, EPRI is developing data on the rates of such interactions for boron, cadmium, selenium, vanadium, zinc, arsenic, and chromium.

OBJECTIVE To develop quantitative data and mathematical descriptions for predicting the chemical attenuation of chromium in subsurface environments.

APPROACH On the basis of a previous literature review, researchers identified several key chromium (Cr) reactions for which data were inaccurate or unavailable. They then designed laboratory experiments to obtain hydrolysis constants of Cr^{3+} and to determine the solubility of chromium hydroxide [$Cr(OH)_3(s)$] and chromium iron hydroxide [$Cr_xFe_{1-x}(OH)_3(ss)$]. In addition, researchers investigated the oxidation of Cr^{3+} to Cr^{6+} and the reduction of Cr^{6+} to Cr^{3+}. Further experiments studied the adsorption of Cr^{6+} by amorphous iron oxide, kaolinite, montmorillonite, and aluminosilicates.

RESULTS Researchers identified geochemical reactions that were previously unknown and developed reaction rate constants. The study showed the following:

- Precipitation-dissolution reactions in equilibrium with $Cr(OH)_3(s)$ and/or $Cr_xFe_{1-x}(OH)_3(ss)$ control aqueous concentrations of Cr^{3+}.
- Precipitation-dissolution kinetics cause reactions to reach equilibrium rapidly.
- The amount and specific surface area of manganese dioxide control oxidation of Cr^{3+} to Cr^{6+}.
- The ionic composition and pH of the groundwater strongly influence the degree of Cr^{6+} adsorption on amorphous iron oxide.

Given these findings, researchers concluded that the Cr in groundwater will most likely take the form of Cr^{3+} and that between pH levels of 5 and 10, Cr^{3+} concentrations will be at least an order of magnitude below drinking-water standards; Cr^{6+} will appear only in highly oxidized conditions. Calculations in this report illustrate the use of these data to estimate chemical attenuation of Cr in the subsurface environment.

EPRI PERSPECTIVE

This report indicates that mechanistic studies can provide information for modeling chemical attenuation and accurately predicting solute migration in the subsurface environment. Laboratory experiments with soils from power plant sites are now under way to verify the use of mechanistic data for modeling important Cr precipitation-dissolution and adsorption-desorption reactions. EPRI report EA-3356 summarizes data on chemical attenuation of 21 inorganic elements, and EA-3417 evaluates geohydrochemical models for simulating solute migration. Under RP2485-8, researchers are studying leaching chemistry; under projects RP2485-5 and RP2485-6, they are studying hydrological processes through macrodispersion experiments within saturated and unsaturated soils.

PROJECT

RP2485-3
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