The effect of organic ligands on the solubility of CeO_2 in $NaNO_3$ medium

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Radioactive waste tanks contain a large quantity of high-level nuclear wastes, such as plutonium (Pu), other actinides, and fission products. International governments and agencies are working on the removal and treatment of the nuclear wastes because of their potential environmental impacts. High pH values, various organic ligands, and high temperatures are the main characteristics of the waste tank systems. The thermodynamic properties of plutonium and other actinides in these storage tanks must be known to design rational remediation processes. Therefore, we need to understand the solubility of actinides (IV) in the High Level Nuclear Waste tank systems in the presence of organic ligands, such as EDTA, siderophores (DFOB), acetate, and oxalate. We use cerium (Ce) as a chemical analogue to investigate the hydrolysis of tetravalent actinides because the ionic radius of Ce (IV) is close to that of Pu (IV) and Ce is non-radioactive. Batch experiments were carried out at 25 °C, a pH range from 2.0 to 10, and the ionic strength of 0.1 molal in $NaNO_3$ medium. The solubility of CeO_2 in 0.1 molal $NaNO_3$ at pH=2.1 in the presence of EDTA (100 – 900 µm) is about 32 ppm (± 3%) Ce whereas the solubility in 0.1 molal $NaNO_3$ at pH=2.1 in the presence of the siderophore DFOB (100 – 900 µm) is about 80 ppm (± 2%) Ce. The solubility of CeO_2 in 0.1 molal $NaNO_3$ at pH=2.1 in the presence of acetate or oxalate is about 2 ppm (± 3%) Ce. The solubility of CeO_2 in 0.1 molal $NaNO_3$ at pH=9.0 in the presence of EDTA/DFOB (100 - 900 µm) ranges from 0.1 ppb to 2 ppm (± 5%) Ce whereas in 0.1 molal $NaNO_3$ at pH= 9 - 10 in the presence of acetate/oxalate is 0.01 – 0.03 ppb (± 10%) Ce. The solubility of CeO_2 in $NaNO_3$ medium in the presence of organic ligands strongly depends on the pH value and the concentration of organic ligands. $Ce(OH)_3^+$ and $Ce(OH)_4^0$ are probably the predominant species under these conditions.

Environmental risk assessment and remediation of soils contaminated due to waste disposal from tannery industries: A case study of Ranipet industrial area, Tamil Nadu, India

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Rapid industrialization coupled with inadequate environmental management in the developing country like India, resulted in large-scale pollution of the environment. The leather industry, besides being a major contributor to the Indian national economy, is unfortunately also one of the major polluters. In this regard, environmental geochemical studies were carried out in and around Ranipet industrial area, Tamil Nadu, India to find out the extent of chemical pollution in soils due to waste disposal from tannery industries. Ranipet is located at 79°19’ – 79°22’ E longitude and 12°53’ – 12°57’ N latitude, and it is chronic polluted area and one of the biggest exporting centers of tanned leather. Geologically the study area is covered by crystalline rocks of Achaean and Proterozoic age consisting of fissile hornblende gneiss, granitoid gneiss, granite and some basic intrusive bodies. The climate of the study area is semi-arid type. The total number of tannery industrial units located in and around this town is 240. The tanneries use the chrome-based methodology for the tanning and no special attention is paid to the disposal of effluents. One hundred soil samples were collected during two hydrological cycles and were analyzed for major, minor and trace elements by XRF spectrometry.

Our study reveals that the soils in this area are contaminated and show very high concentrations of some of the heavy / toxic metals, such as Ba ranging 272-1391mg/kg (783 mg/kg average), Cr 71-10280 mg/kg (1375 mg/kg average), Pb 11-126 mg/kg (43 mg/kg average), Sr 107-450 mg/kg (249 mg/kg average), V 19-3583 mg/kg (168 mg/kg average) and Zn 45-585 mg/kg (113 mg/kg average). Studies were carried out on surface and ground water samples by ICP–MS spectrometry, which also indicate high concentration of toxic elements like Cr ranging 22 to 514 µg/l (69 µg/l average), Ni 11.62 – 414 µg/l (44 µg/l average), Zn 21 – 34506 µg/l (7052 µg/l average), Sr 439 – 13093 µg/l (2390 µg/l average), Cd 0.18 – 38562 µg/l (2390 µg/l), Pb 14 – 28978 µg/l (1463 µg/l). High concentrations of these toxic elements are responsible for the degradation of human health of people in the study area and they suffer from occupational diseases such as asthma, chromium ulcers and skin diseases. Distribution and correlation of these heavy metals in soil and water, along with possible remedial measures are discussed.