URANIUM SORPTION FROM AQUEOUS SOLUTIONS ON SODIUM-FORM OF HEU-TYPE ZEOLITE CRYSTALS

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(Received July 20, 1995)

The uranium sorption from aqueous solutions (concentration range 50-20,000 mg/l) by the sodium-form (Na-form) of HEU-type zeolite crystals (particle-size < 20 μm) has been investigated by means of a batch-type method. The INAA, RI-XRF, powder-XRF, SEM-EDS and FT-IR techniques were used for the study of the experimental products. The absolute uranium uptake by the material reached the value of 11.68 mg/g in the case of initial concentration 20,000 mg/l. On the other hand the K values indicated that the relative uranium uptake, and consequently the percentage of removal, is higher for concentrations below 100 mg/l. The uranium uptake by the zeolite is attributed to different sorption processes such as ion-exchange, adsorption and surface precipitation, taking place both to the interior and the surface of the crystals and strongly depending on the pH of the solutions. The investigated zeolitic material was sufficiently resistant at the low initial pH of the solutions with dealumination phenomena only observed in the case of the most acidic solution used.

Although uranium is one of the naturally occurring actinides, its presence in the biosphere is not only attributed to natural sources (uranium-containing minerals and rocks) but also to certain human activities mainly related to the nuclear power production. Significant amounts of uranium are released to the environment during the entire nuclear fuel cycle, including the uranium ores processing and the final nuclear-waste disposal in geological repositories1. Uranium anthropogenic contamination has been observed due to other reasons such as the phosphate fertilizers production and utilization, the coal burning in power stations and the copper ores processing2,3.

The transport of uranium in the environment and its involvement in geochemical and biogeochemical cycles takes mainly place through aquatic pathways existing in the geosphere. However, the uranium mobility and accumulation in natural systems strongly depends on interactions with geological materials and immobilization processes such as sorption to rocks, minerals and suspended solid particles. Of especial interest are the interactions of dissolved uranium species with natural porous and particularly microporous solid phases (e.g. clay minerals, oxides/hydrous oxides/hydroxides/oxyhydroxides, zeolites, micas) showing the ability to sorb considerable uranium amounts from aqueous media. The investigation of the interactions between zeolites and uranium in aqueous environments is of increasing importance, because areas with zeoliferous rocks (mainly...
The HEU-type zeolite specimen selected for the present study was pure heulandite crystals developed into a cavity of a basaltic rock sample from Poona/India. Distinct zeolite crystals were crushed in an agate mortar and wet-sieved in analytical sieves for the separation of the 20-90 μm and <20 μm particle-size fractions. The coarse- and the fine-grained crystalline powder obtained was repeatedly treated with 4M NaCl solution at 100 °C in order to obtain the homoionic Na-form of the zeolite13. The starting material was characterized by means of powder-XRD (PHILIPS 1820 PW diffractometer, CuKα radiation) and analyzed in thin-polished sections using SEM-EDS (JEOL, JSM 840-A with a LINK 10000 AN EDS, 20 μm defocused beam).

Both the coarse- (20-90 μm) and the fine-grained (<20 μm) zeolite crystals, in the Na-form, were used for preliminary uranium sorption experiments. These experiments...