

## The interaction of uranyl-gluconate complexes with hydroxyapatite

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An important mechanism in the migration of the actinides in the environment is their interaction with mineral surfaces. The calcium phosphate mineral, hydroxyapatite, has been investigated as a potential backfill material for geologic repositories. Hydroxyapatite has been shown to remove uranyl (U(VI) as the  $\text{UO}_2^{2+}$  cation) from aqueous solution *via* the formation of inner-sphere complexes at low U concentrations. At higher concentrations, uranyl is removed by the precipitation of a uranyl phosphate solid phase.

Organic complexants are ubiquitous in the environment, either as natural components or derived from anthropogenic sources. Polyhydroxocarboxylic acids are very common, and include oxidative products of glucose (e.g. gluconic acid (GA)). GA has also been used in many industrial processes including the nuclear fuel cycle.

The presence of complexants such as GA will affect the solution speciation of uranyl and its interaction with minerals such as hydroxyapatite. In this study, the interaction of uranyl with hydroxyapatite has been investigated in the presence of the gluconate anion, as a function of various experimental parameters including metal concentration and pH. The adsorption to the mineral surface has been modeled using the diffuse double-layer model.

## Uranium enriched in carbonised wood: Role of microbes on uranium immobilization

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Reduction of U(VI) to U(IV) by microorganisms, especially bacteria, leading to U(IV) deposition was extensively studied in the experimental conditions of dilute uranium-bearing solution<sup>1</sup>. However, there has been few direct evidence of naturally uranium mineralization by microorganisms. Here, we present a natural evidence that primary uranium minerals, uraninite and coffinite, usually adopt characteristic forms defined by the geometries of microfungi and bacteria, indicating a biogenic minerals, in high-grade ores (>1%) of some sandstone-hosted uranium deposits, Xinjiang, NW China. It may be attributed to that alive microorganisms enzymatically reduced and accumulated U(VI), and grew using U(VI) as the sole electron acceptor during early biomineralization. The results not only provide the first example of biogenic, natural uraninite and coffinite, but also first demonstrate that microorganisms have played a key role in formation of the sandstone- or roll-type uranium deposits, the most abundant uranium reservoir in the world. The wood pieces are the most uranium-rich "phase." It is proposed that organic components from the wood cells' decay provide nutrients for the anaerobic bacteria to grow. The wood pieces with the bacteria inside may serve as sinker for uranium because of its local reducing chemical environment. Our laboratory experiments with *Shewanella putrefaciens* and *Desulfovibrio desulfuricans* DSM 642 that were embedded in porous polymers show that both bacteria are able to reduce U(VI) and precipitate (immobilize) uraninite inside the porous polymer (analog for porous wood). The research was supported by National Natural Science Foundation of China (Grant No. 4017303, and 40210104086) and University of Wisconsin.