

## Synthesis and mineralogical characterization of members of the voltaite group

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We performed detailed studies of the mineralogical properties of the voltaite group, which, despite its large number of different members, still lacks a comprehensive characterization. The samples precipitated from an acidic solution that contained the corresponding metal sulfates. The proportions of these salts were chosen either according to the respective chemical formula or in compliance with the methods of Mereiter [1] or Goßner [2]. The crystallization process took place at a temperature of 353 K and lasted between two and three days.

The thus obtained euhedral voltaite crystals were analyzed using an electron microprobe, yielding an excellent agreement with the theoretical formula  $K_2\text{Me}(+\text{II})_5\text{Fe}(+\text{III})_3\text{Al}(\text{SO}_4)_{12} \cdot 18\text{H}_2\text{O}$ , where  $\text{Me}(+\text{II}) = \text{Fe}(+\text{II}), \text{Mg}, \text{or Zn}$ . The phase identification and subsequent Rietveld refinement was performed by means of powder XRD and the crystallographic software package GSAS. The refinement showed a systematic decrease of the lattice parameter in the solid solution from the Fe(+II)- to the Mg-endmember. This result is consistent with the smaller effective ionic radius of Mg compared to that of Fe(+II). When viewed in plane-polarized light, the Mg and Zn endmembers of the voltaite group were colorless, whereas all other solid solutions of the Fe(+II)-Mg-Zn system exhibited a typical green color. Under crossed polarizers, the crystals, which were up to 0.5 cm across, showed an anomalous anisotropy towards the edges. These optical anomalies increased with the increasing substitution of Fe(+II) by Mg or Zn, and suggest at least small deviations from the nominal cubic symmetry of voltaite. Further characterization of the synthesized voltaite-group members by means of IR and Raman spectroscopy, single-crystal XRD, and DTG are planned for the near future.

[1] Mereiter K. (1972) *Tsch. Min. Petr. Mitt.* **18**, 185-202.

[2] Goßner B. & Arm M. (1930) *Z. Krist.* **72**, 202-236.

## Interaction between *Paramecium bursaria* and Europium(III)

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### Introduction

It is known that activity of microorganism has a great impact on the geological migration of the radionuclides leached from radioactive waste forms. Retardation by adsorption on the cells is the most desirable function of bacteria. It is also known that protozoa, who prey bacteria, are found in deep ground water. To elucidate the role of protozoa in the migration of radionuclides, the behavior of *Paramecium bursaria* in media containing Eu(III) with or without addition of bacteria as a food source was investigated. Eu(III) was used as simulant of trivalent actinides.

### Results

When cells of *P. bursaria*, which were cultured, harvested, and washed beforehand, were contacted with a salt solution containing Eu(III) for 24 h, a fraction of the cells died at 0.05 mM or higher concentrations of Eu(III) (Table 1). This result indicates that Eu(III) is toxic to *P. bursaria*.

Eu(III) concentration	Fraction of the cells survived
0	1.00
0.01 mM	1.00
0.05mM	0.90 ± 0.05
0.1 mM	0.27 ± 0.06
0.5 mM	0.00

**Table 1:** Survival fractions of *P. bursaria* in Eu(III) solutions. The solutions contained 2360mg/L of NaCl, 267mg/L of  $\text{Ca}(\text{NO}_3)_2$ , 26.7mg/L of  $\text{MgSO}_4$ , 0.9mg/L of  $\text{Fe}_2(\text{SO}_4)_3$ , and 99.2mg/L of  $\text{C}_3\text{H}_7\text{Na}_2\text{O}_6\text{P}$ . The pH was adjusted to 7.0. The Eu(III) added was  $\text{Eu}(\text{CH}_3\text{CO}_2)_3$ .

After *P. bursaria* cells were cultured with the *B. subtilis* cells on which Eu(III) was adsorbed in advance, a fraction of the Eu(III) was found in liquid phase as organic colloid and another fraction was detected in extracellular polymyric substances formed by the growth of the *P. bursaria* cells. This result indicates that the activity of *Paramecium* sp. may change chemical and physical states of radionuclides.