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# Forms of lanthanides sorbed by quartz and goethite in the presence of microorganisms

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Forms of lanthanides sorbed by quartz sand and goethite precipitated as coatings on a sand matrix in the presence of *Rhodopseudomonas pallustris* at different pHs were studied. Goethite was prepared by adding 0.17M $Fe(NO_3)_2$ and 0.52M NaOH in the evaporating dish. After cultivation of bacteria and filtration of liquid medium the suspension of microorganisms in water ($4.8x10^8$ cells in $ml^{-1}$) was added to quartz sand or goethite with the mixed solution of lanthanides (C = 15ppb). The experiment was carried out at pH 4, 7 and 9. Tubes with microorganisms and controls (no inoculum) were incubated without shaking at 22˚C. After experiment concentrations of REE in equilibrium solutions were determined and the exchangeable (extracted by 0.5M NH4NO3) and the nonexchangable (extracted by 0.3M NH2OH-HC1 in 1M HN03) forms of elements were recovered from the surfaces of minerals. The concentrations of REE were determined by ICP MS. At acid conditions quartz and goethite practically are not sorbed lanthanides. Zero point charge (ZPC) of synthetic pure goethite may be located at pH 7.6 (Forbes et al., 1986) and ZPC of SiOOH-groups is located at pH 1-3.7 (Pinsky, 1997). So, at pH 4 surfaces of quartz and goethite have mainly positive charge and repel cations of lanthanides. Our experiment demonstrates that the weakly bounded exchangeable forms play a dominant role in the adsorption of lanthanides. Microorganisms reduced slightly concentrations of rare earth elements in the solution. Most probably the main reason for the increasing of sorption is interaction and retention of microorganisms on surfaces of the iron mineral. The amount of retained elements in the presence of *Rhodopseudomonas pallustris* is increased primarily due to increasing their concentrations in the exchangeable forms also. At neutral conditions quartz sorbed about 3-15 % of the metals primarily in the exchangeable forms. In the course of incubation with *Rhodopseudomonas* about 97% of the added elements were

sorbed. The amount of lanthanides was increased due to increasing their concentrations in the nonexchangeable forms. At these conditions goethite-coated sand without microorganisms sorbed from solution 94-96 % of the different elements, principally in exchangeable forms. Microorganisms slightly increased sorption of lanthanides by goethite at these conditions. The concentration of the elements in the exchangeable forms was reduced and in the nonexchangeable form was increased. At alkaline conditions quartz has high sorption capacity to the REE. In the presence of microorganisms the sorption of metals from solution was grown in the exchangeable and the nonexchangeable forms. The opposite trend was detected for goethite – microorganisms increased concentrations of lanthanides in the sorption solution. Our work demonstrated that in spite of same chemical properties of lanthanides there were differences in their sorption (for example Sm, Eu and Ho, Er, Tm). Perhaps there are periodical changes of chemical affinity of lanthanides to mineral and biological surfaces. The research was supported by INTAS program for young scientists.