Biological nano-mineralization of Yb phosphate by *Saccharomyces cerevisiae*

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Introduction

The geochemical behavior of lanthanides and actinides has created extensive interest in their environmental impact. Some recent studies have reported that the migration of REEs and actinides is affected by microorganisms present in nature due to their high capacity to adsorb metal cations. In order to understand the process of post-adsorption, our previous studies using Ce (III), one of the light REEs, have demonstrated the Ce (III) phosphate nano-sized mineralization by *S. cerevisiae* with monazite structure. In this study we continue to investigate the association of heavy REE of Yb with yeast *S. cerevisiae* after exposure at pH of 3, 4 or 5. A variety of analytical techniques including FESEM-EDS, TEM, ICP-AES, XAFS have been employed to investigate the sequestration mechanism of Yb by yeast as a function of exposure time.

Results and discussion

Ytterbium concentrations in solutions decrease as the exposure time increases. It is also shown that higher pH solution and higher density of the yeast cells sequester Yb more rapidly from solution than the lower ones. FESEM, TEM, and XAFS analyses revealed that nano-sized blocky Yb phosphate with amorphous phase formed on the yeast cells surface after 24 h. The numbers of the Yb containing precipitates increase from several at 2 h to more than 100 on the one cell surface. Lower pH resulted in higher P concentration in the solution after the yeast cells were inoculated, indicating release of P from the inside of yeast cells. These results suggest that the sorbed Yb on the cell surfaces reacted with P released from inside of the yeast cell, resulting in the formation of amorphous Yb phosphate. This post sorption process on the microbial cell surface should be a key role to constrain the long-term migration of REEs and trivalent actinides in geological repository.

Two stages of gold mineralization in Tibet

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Two stages of orogenic gold mineralization has been identified in Tibet. The first stage of gold mineralization was formed during the early stage of the Indo-Asian collision, represented by Mayum, Bangbu, Juqu and Jindong gold deposit in western Tibet, while the second stage of gold mineralization was formed during the late stage of the collision, examples as Daping, Mojiang and Laowangzhai gold deposits in Ailaoshan area, southeastern Tibet.

Of course, these two stages of gold mineralization were controlled by the orogenesis, and occur within the green schist facies of metamorphic terrains. The ore-forming fluids are typical of metamorphic, characterized by rich CO_2. Nevertheless, they are different in tectonic setting, timing, and origin of the ore fluids. The first stage of gold mineralization was related to the crustal thickening resulted in extensive asthenospheric upwelling due to the Indo-Asian collision. Increasing heat flow in a thickened crust may have triggered the release of large amounts of ore-bearing fluids from the stressed strata. These fluids subsequently were focused at the brittle-ductile transition into low-order structures.

By comparison, the second stage of gold mineralization was controlled by deep shearing and shallow strike-slip faulting during the transforming of the late collision, resulted in melting and upwelling of mantle materials. The ore fluids both from mantle breathing and lower crust dehydrating migrated along the ductile shear zones, and deposited to form the gold deposits.