Flavin mononucleotide mediated reduction of U(VI)

Y. SUZUKI* AND T. OHNUKI

Research Group for Hevey Element Biogeochemistry, Japan Atmic Energy Agency, 2-4, Shirakatashirane, Tokai, Ibaraki 319-1194, Japan
(*correspondence: suzuki.yoshinori@jaea.go.jp)

Introduction

Shewanella species secreat flavin mononucreotide (FMN) and ribofrabin those play an important role in the extracellular electron transfer [1,2]. In this study, we examined the electron transfer between FMN and U(VI).

Experimental

Electrochemical analysis: Cyclic voltammograms (CVs) of FMN in the buffer solution containing 50 mM sodium citrate and 50 mM Tris were obtained in the absence and presence of U(VI). An optical transparent thin-layer electrode (OTTLE) was employed for spectro-electrochemical measurements.

Bioreduction experiment: *Shewanella putrefaciens* was incubated in anaerobic media containing 2 mM $UO_2(NO_3)_2$, 10 mM lactic acid, 50 mM sodium citrate and 20 mM HEPES at pH 6.6 with or without 0.1 mM FMN. Concentrations of U(IV) were monitored by a UV-Vis spectrometry.

Results and Discussion

The CV of FMN at pH 6.0 showed a couple of clear redox peaks at -0.36 V (*vs.* Ag/AgCl). Addition of U(VI) into the solution made the reduction peak current increased and the oxidation peak current decreased. The reduction peak current increased with an increase of the U(VI) concentration. These results indicate that FMN mediates the electroreduction of U(VI). The bulk electrolysis at -0.55 V using the OTTLE showed that the absorbance at 660 nm attributable U(IV) species increased with time. The bioreduction experiment showed that the reduction rate of U(VI) in the medium with FMN was faster than that without FMN. These findings suggest that FMN may act as an electron shuttle between the bacteria and U(VI).

[1] Canstein *et al*. (2008) Appl. Environ. Microbiol., **74**, 615.
[2] Marsili *et al*. (2008) PNAS, **105**, 3968.

Towards a world of limits: The issue of human resource follies

H. SVERDRUP[1]*, D. KOCA[1] AND K.H. ROBÉRT[2]

[1]Applied Systems Analysis & System Dynamics (ASASD) Group, Lund Univ., Box 124, 221 00, Lund, Sweden
(*correspondence: harald.sverdrup@chemeng.lth.se)
[2]The Natural Step, Sveavägen 98, 5th floor, 113 50, Stockholm, Sweden

The issue of sustainability builds on the understanding that the resources of the world are not endless, and that the aspects of the human global resource metabolism has outgrown the carrying capacity[1,2]. This study forward the hypothesis that human resource use will empty the worlds reserves of major metals and materials (i.e. 1. *Metals for infrastructure and technology;* 2. *Essential elements for human subsistence;* 3. *Resources for energy generation*) within one or a few generation unless a new world resource planning strategy is adopted and developed (Table 1).

Class	Scarcity limit	Element
Imminent scarcity:	< 30 years	helium, silver, gold, zinc, tin, indium
Peak resource:	> 30 years, and < 200 years	phosphorus, zirconium, nickel, iron, copper, oil, natural gas, uranium for conventional nuclear energy, thorium for conventional nuclear energy, wolfram, lithium, molybdenum, platinum, palladium, rhodium, niobium
Long term shortage:	> 200 years, and < 10,000 years	cobalt, aluminum, coal, tantalum
Sustainable perspective:	between the length of an interglacial stage (10,000 yrs) and a full glacial cycle (100,000 yrs)	chromium, lanthanides, uranium for breeders, thorium for new technology

Table 1: Classification of elements for the time to the scarcity limit

More and more of our metals and fossil energy are dissipated into the world, the metals are diluted, irretrievably lost and the embedded energy is dissipated. As rich deposits are exploited and the proceeds dissipated, and recycling remain haphazard, extractions costs will rise exponentially.

[1] Meadows *et al.* (1972) *Limits to growth.* [2] Bossel (1998) *Earth at the crossroads. Paths to a sustainable future.*