The outline of SATREPS project

AIM

1. Elucidating the pollution mechanism of lead in ecological system, human and animals
2. Follow up study to the harmful metal pollution in children
3. Development and evaluation of the on-demand environmental remediation technology

The outline of a project

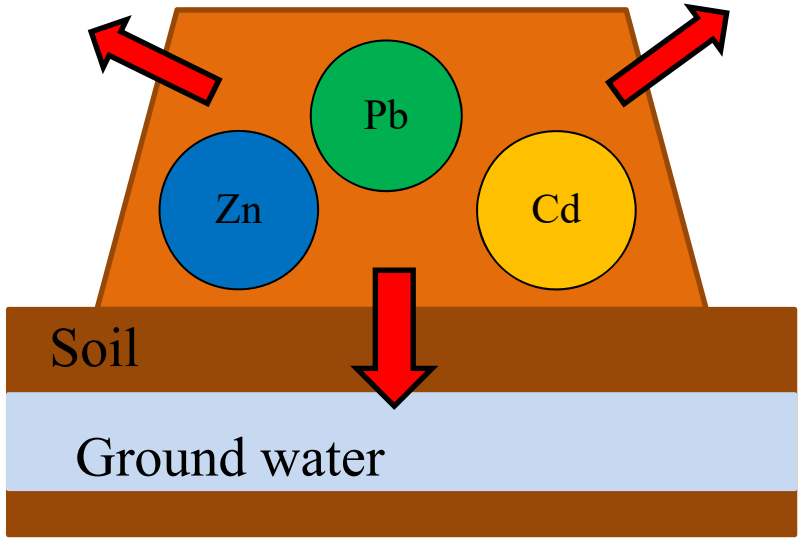
Contents (Group)	Approach	Outputs
Elucidating a pollution mechanism in ecological system and human 1	a. Measurement of lead in soil and environment samples b. Wide area surveillance of lead (remote sensing)	• Elucidation of the shift mechanism of lead to human • New vege • Sim diffusion
Follow up study to the harmful metal pollution in children 2	a. Risk assessm hazard with b. Economic ass the hazard wit	toxic mechanism expert training • Therapy protocol of the chronic poisoning
Environmental remediation 3	a. Physical remediation b. Chemical remediation c. Bio-remediation and phytoremediation	• New environmental remediation technology of the soil

a.Physical
b.Chemical
c.Bio-/ phyto- remediation

Group3 Research topics

- Characterization of mine wastes (boring core)
- Critical pathways of Pb: dispersion with dust, surface runoff, and infiltration into underground
- Remediation technology of the mine wastes (pilot scale tests, advanced technology (beakar scale)

Mine wastes,
pathways of Pb, air dust,
ground water,
remediation technology



Embankment

Activity

bore holes, air dust,
ground water, pilot scale tests

2016

- Preparation of pilot scale tests

+Bore hole drillings at Kabwe site and UNZA (Groundwater observation well, boring core sampling and analysis)

+Planning of pilot scale tests (test mound: covering soil, adsorbent, plant, environmental checking with UNZA, ZEMA)

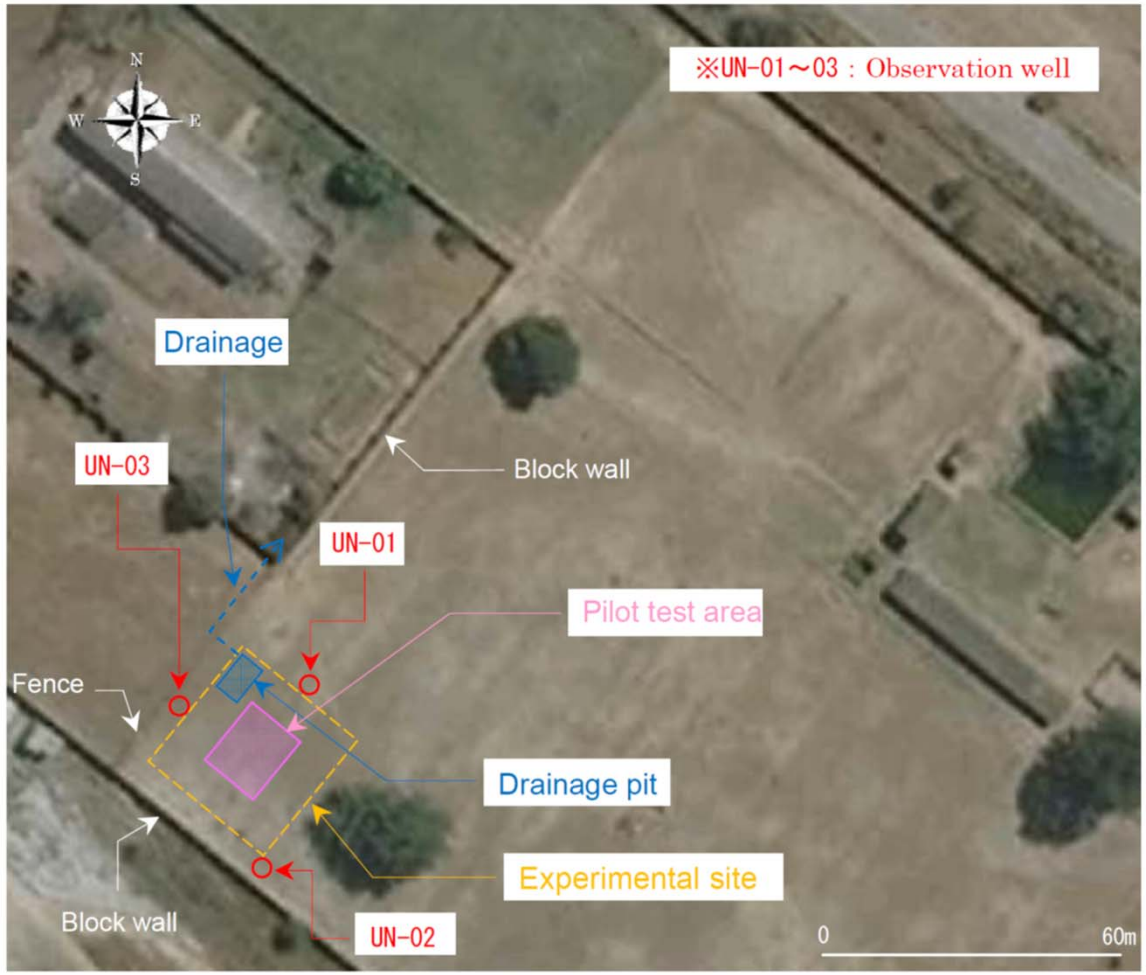
- Air dust collection (trial)
- Sampling and characterization analysis of mining-metallurgical processing waste samples

2017

- Pilot scale tests
- Collaboration research
- Student exchange, invitation of staffs

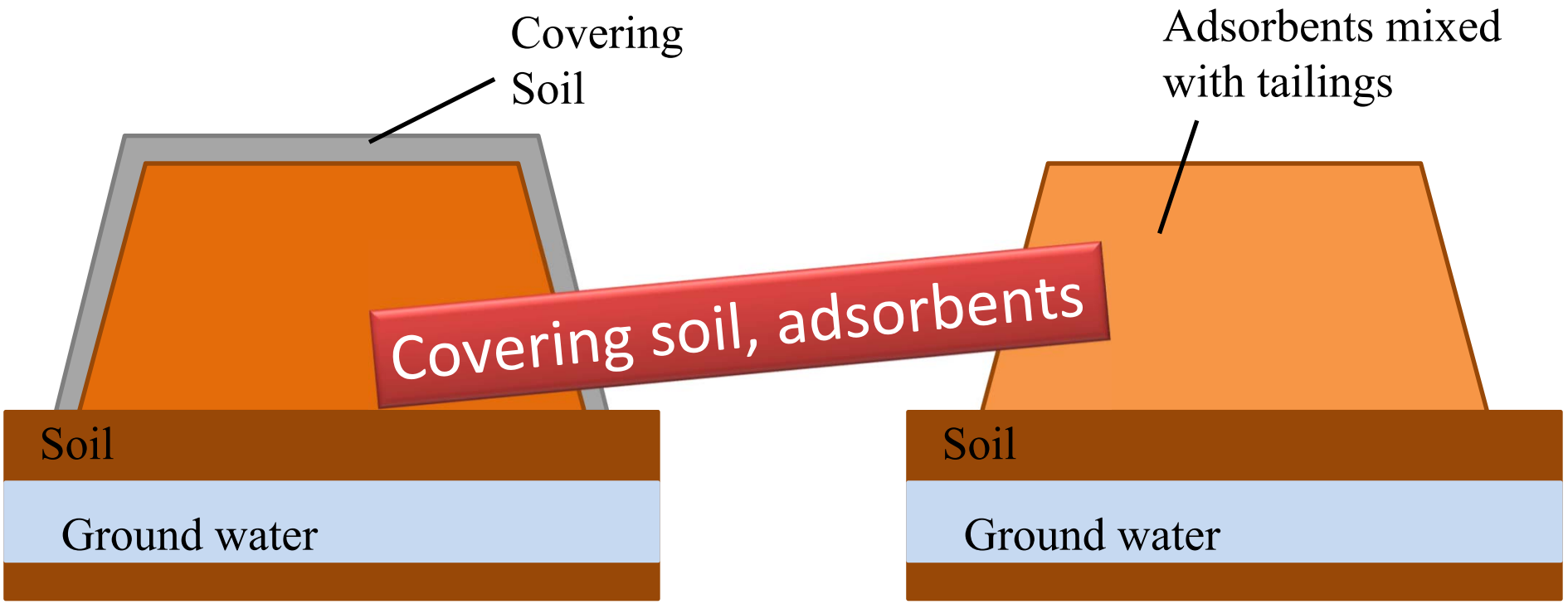
Pilot scale tests in UNZA

location



Pilot test site

Pilot scale tests



Objectives

- **To reduce the heavy metal concentration in dust**
  - →Covering with uncontaminated soils
  - →Covering with sheet or other materials
- **To reduce the solubility of toxic elements**
  - →Mixing with adsorbents for reducing the solubility

Pilot scale tests
Meteorological observation
(weather station)

※One case

1. Direction of wind
2. Velocity of wind
3. Atmospheric pressure
4. Solar radiation
5. Rainfall
6. Temperature
7. Humidity

Group3

Laboratory of
Groundwater and Mass Transport

Prof. T. Igarashi

Kenta Noto

JIn Ota

MITSUBISHI materials techno
(Bore hole, pilot scale tests)

Mineralogy, Geochemistry

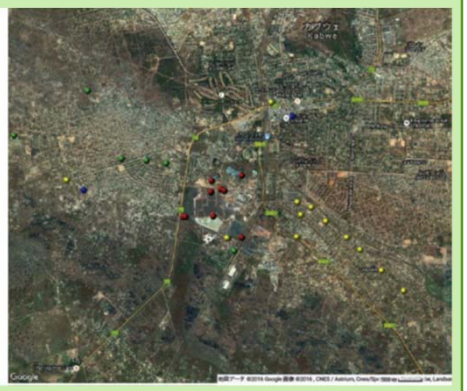
Prof. T. Sato

Assoc. Prof. T. Otake

Kalaba Lawrence Kamegamori

Earth science

Prof. K. Toyota,
S. Tanaka



Majorie Mbambara

Laboratory of Biotechnology for
Resources Engineering

Mwandira Wilson

Assoc. Prof. K. Nakajima

Laboratory of Mineral Processing
& Resources Recycling

Shun Takakuwa

Kazuki Minatogawa

Assoc. Prof. M. Ito

Collaboration research topics with UNZA

Laboratory of
Groundwater and Mass Transport

Prof. T. Igarashi

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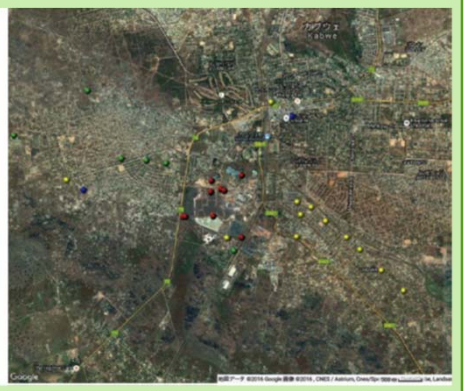

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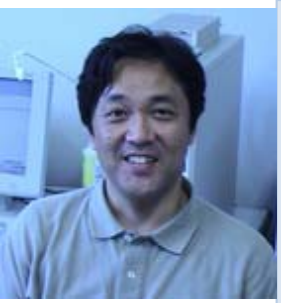


Laboratory of

Groundwater and Mass Transport

Prof. T. Igarashi

Plan for collaborative researches

- Air dust monitoring by sampling and analyzing the dust in Kabwe to characterize the particle distribution of dust and heavy metal content in the dust (5 sampling locations)
- Ground water monitoring in UNZA (3 wells) and Kabwe (3 wells) (every 3 hours) to clarify the chemical properties depending on the groundwater level
- Evaluation of the collect data and collecting undisturbed soil sampling of pilot tests in UNZA to understand the diffusivity of heave metals
- Monitoring meteorological data in UNZA to evaluate the critical pathways of exposure of heavy metals

Laboratory of Mineral Processing
& Resources Recycling

Shun Takakuwa
Kaduki Minatogawa

Assoc. Prof. M. Ito

Soil washing method:

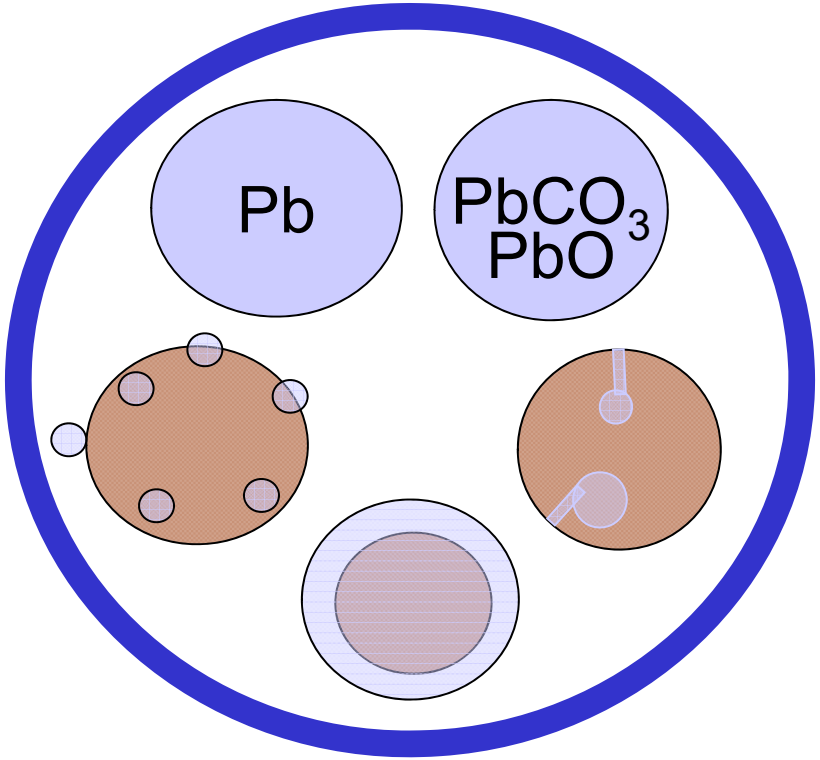
Leaching and recovery of metals

Leaching: chelating agents (Cl-, citric acid..)

Recovery: cementation (electrochemical) reaction

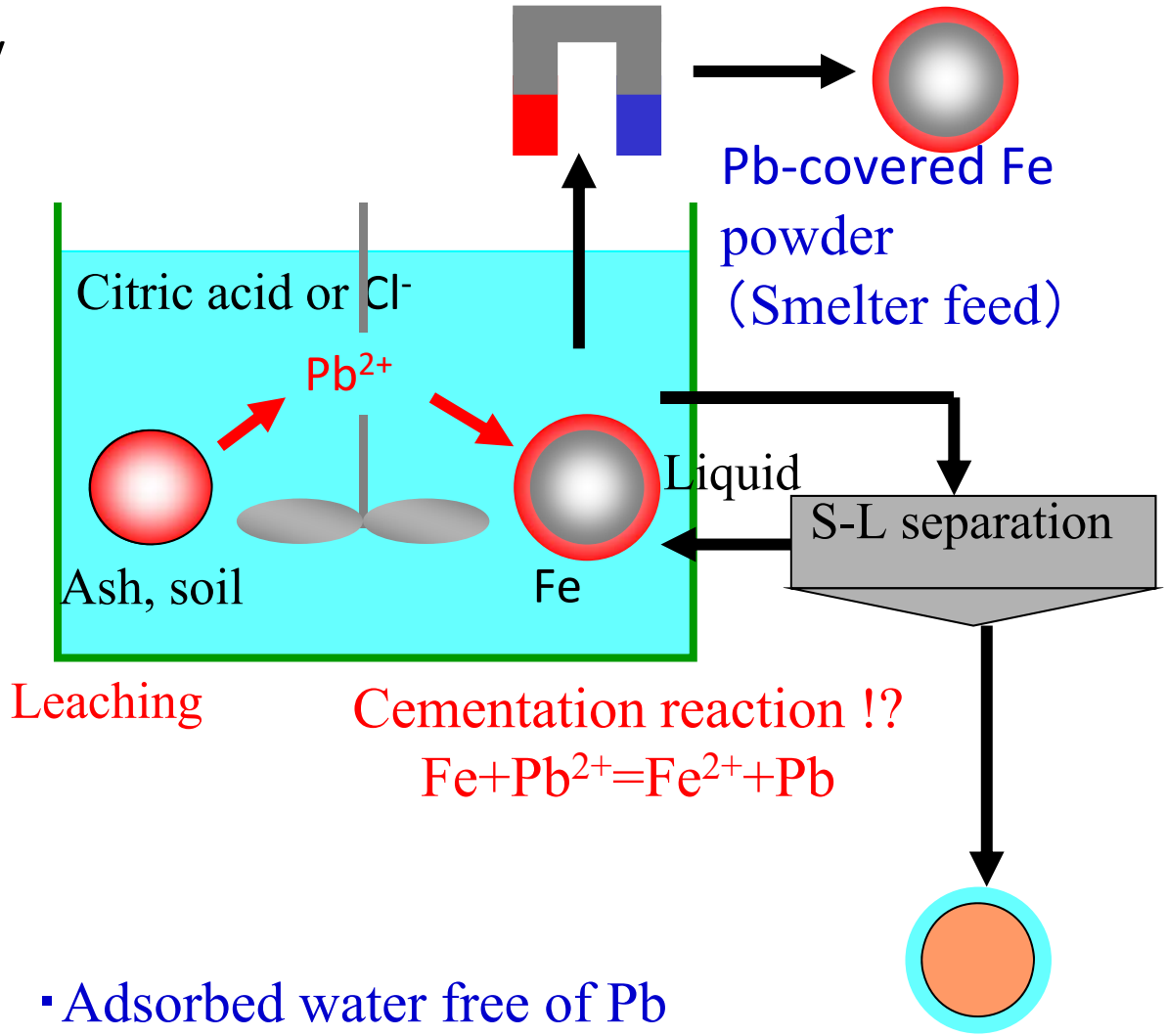
Physical and chemical treatment techniques to recover heavy metals

Heavy metals in municipal solid waste fly ash and contaminated soil



Difficult to separate by physical separation methods

Magnetic separation

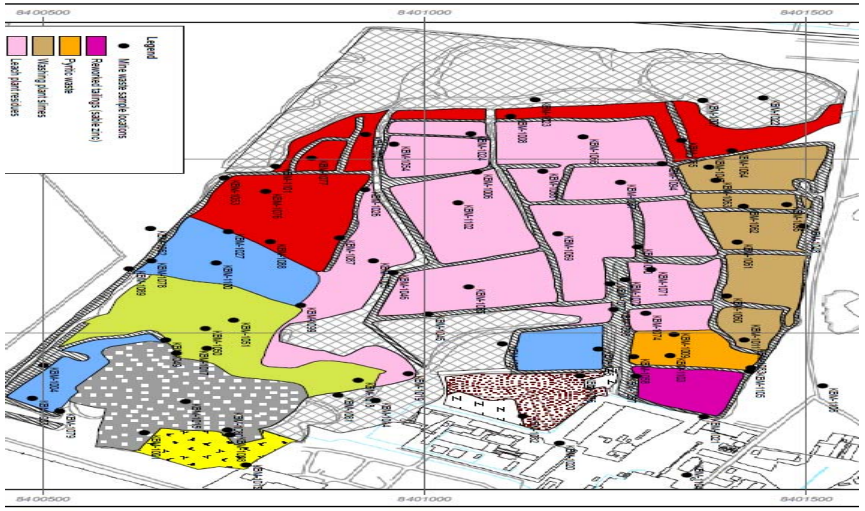


- Adsorbed water free of Pb
- Conventional techniques : water not Pb-free

Prof. T. Sato
Kalaba Lawrence

SOURCES AND TRANSPORT MECHANISM OF HEAVY METALS IN KABWE AREA, ZAMBIA

SAMPLE COLLECTION AND ANALYSIS



Sample collected

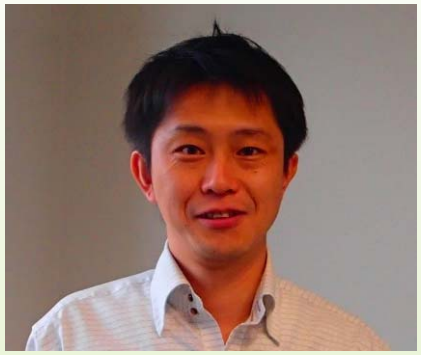
- 1) Leaching residue sample
- 2) Zn sulfate
- 3) Wealz kilm sample
- 4) (Imperial smelting furnance) ISF-slag sample
- 5) Sato Sensei inspecting one of three borehole drilled in the study area
- 6) Shows core samples collected

Expected samples to be collected

Water samples (Surface and groundwater)

Sample Analysis

Doing XRD and XRF for these four samples, others are SEM-EDS and EPMA
Petrographic study for core samples
ICP-AES, ICP-MS and IC for water samples once collected



Laboratory of Biotechnology for Resources Engineering

Assoc. Prof. K. Nakajima

Research plan for bioremediation of lead contaminated site, Kabwe, Zambia.

Mwandira Wilson

Laboratory of Biotechnology for Resources Engineering

Supervisor: Professor Kazunori Nakashima

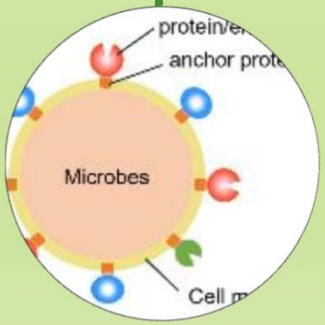
1st March 2017

GENERAL RESEARCH METHODOLOGY

Lead Bioremediation

Water Bioremediation

Soil and sediment Bioremediation



Metal-binding microbes by genetic manipulation

Biomineralisation

Biocementation using urease-producing microbes

Ground improvement technique using microbes

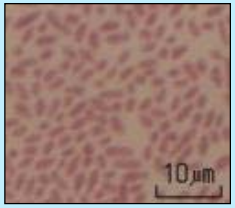
⟹ environmentally friendly

Mechanism :

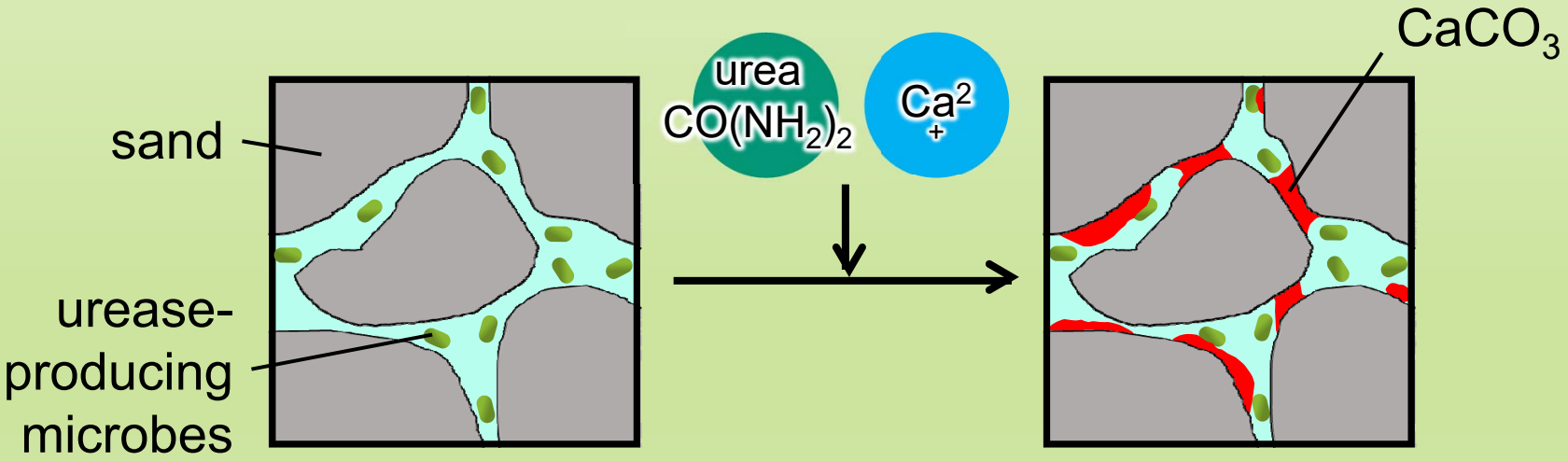
$$CO(NH_2)_2 + 2H_2O \xrightarrow{\text{urease}} 2NH_4^+ + CO_3^{2-}$$

(urea)

$$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3\downarrow$$

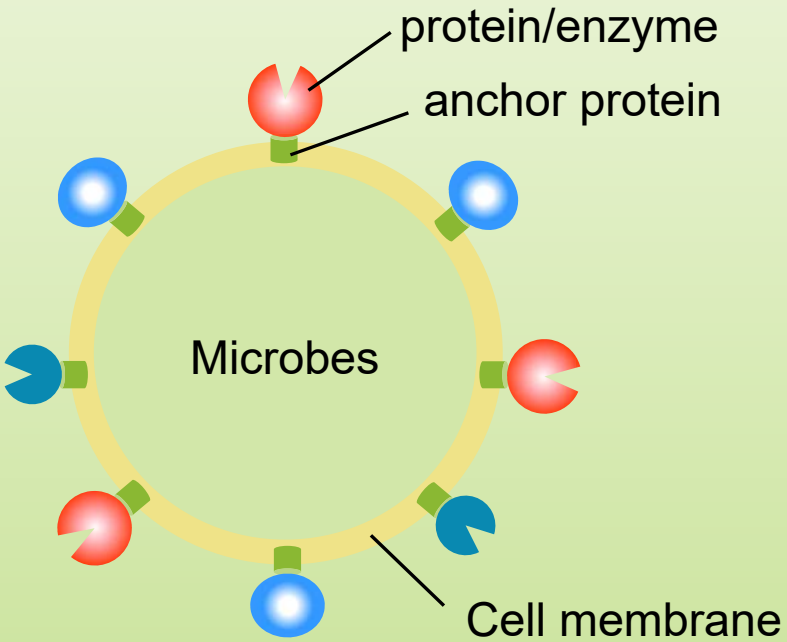


Pararhodobacter sp.

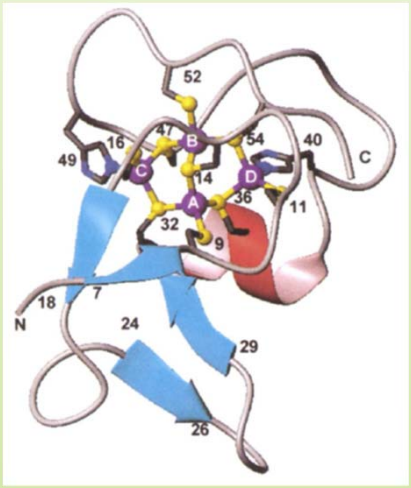


Cell surface display system of microbes

Cell surface display



Metal-binding protein



PNAS, 2001, 98, 9593

metallothionein

Binding metal:

Zn

Cu, Cd, **Pb**,

Ag, Hg etc.

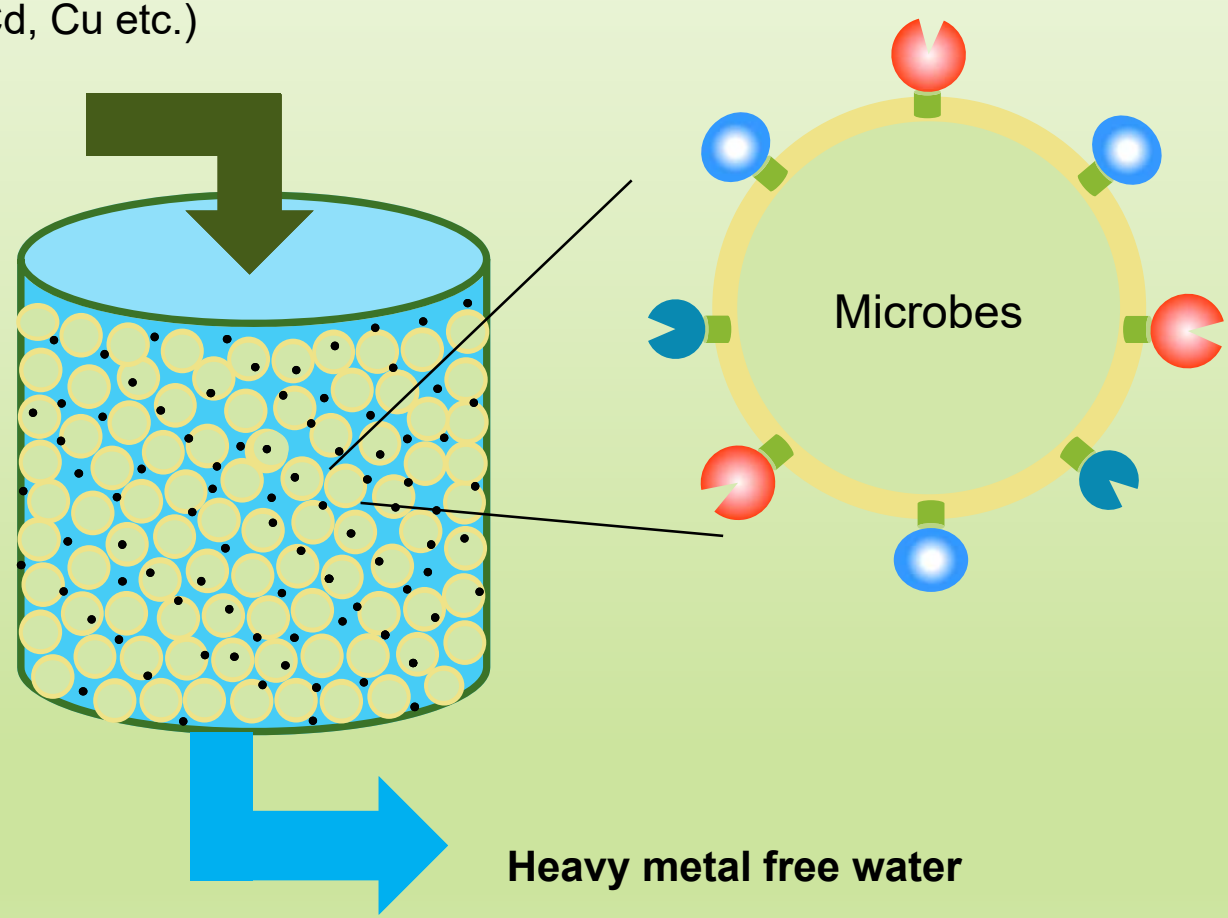
Biding site:

Cys (-SH)

Functional microbes harboring metallothionein on its cell surface

Cell surface display system of microbes

Heavy metal contaminated water
(Pb, Zn, Cd, Cu etc.)



POSSIBLE AREAS OF RESEARCH COLLABORATION WITH SCHOOL OF MINES

- **Isolation of urease-producing microbes in Zambia**
- **Solidification test using indigenous microbes**
- **On-site solidification for bioremediation in Kabwe**
- **Treatment of Pb-contaminated water in Kabwe**

Thank you