

# Governments, Industry, and Universities: An Innovation Ecosystem

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THE UNIVERSITY OF  
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# Desirable outcomes

Highly skilled  
workforce

Economic  
development

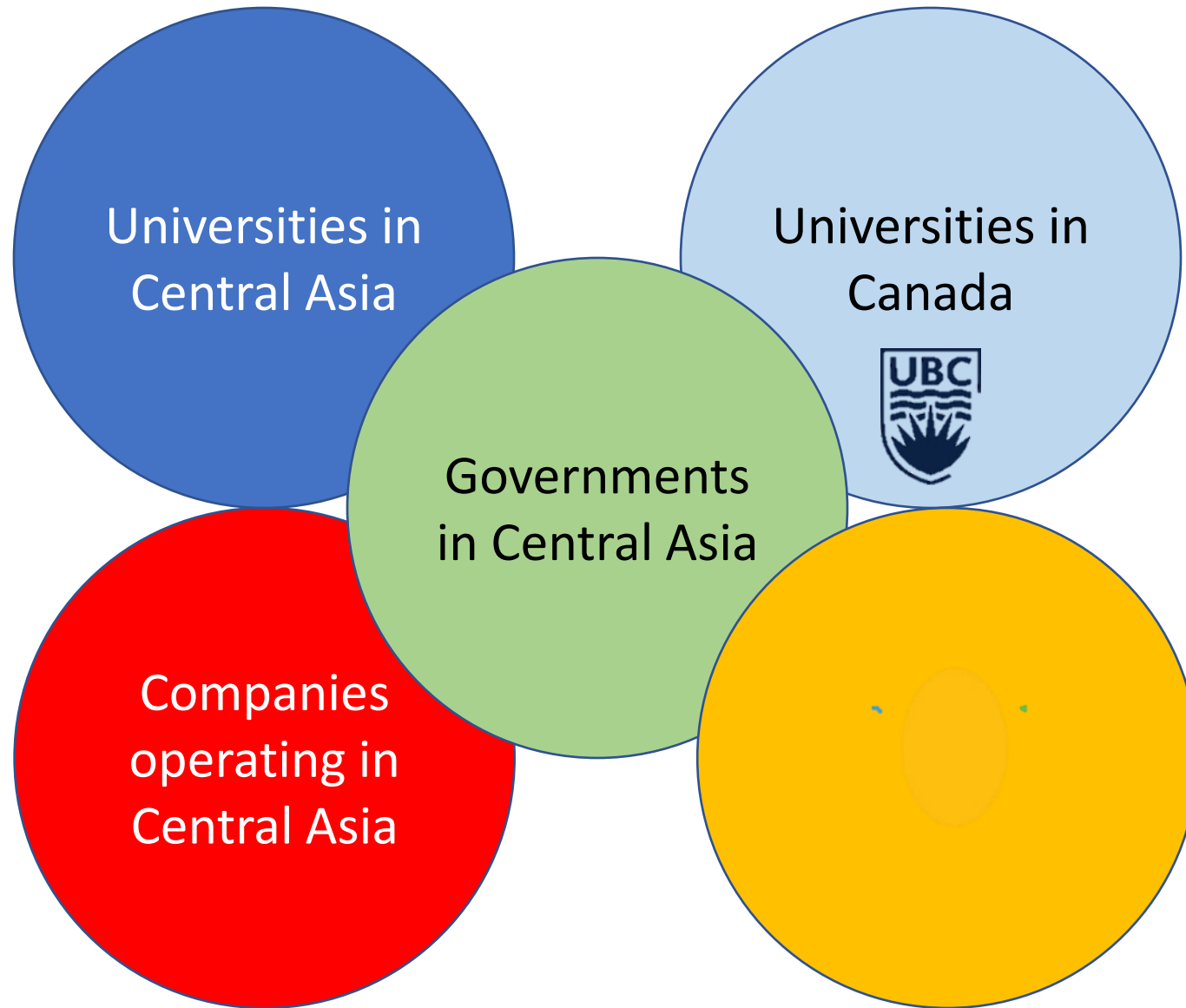


Central Asia. Cartography by Samuel Philipian

Environmental  
protection

Access to  
resources

Advanced state  
of the art





~70,000 students

**Applied Science:**

- Six engineering departments, Four programs, Three schools

**Faculty of Arts:**

- 25 departments (including Asian Studies with ~100 faculty)
- School of Public Policy and Global Affairs

**Faculty of Science:**

- 10 departments, Two institutes

**Business school**

**Law school**

Teaching and research related to Mineral Resources occurs in many of these units.

# Topics

- Big mines or smaller mines
- Some mining technologies
  - Ore sorting
  - Mobile processing plants
  - Swarms of small haul trucks
  - Mineral microbiome

# Big versus Small

Large mining projects	Smaller mining projects
High capital cost	Lower capital cost
Complex	Simpler
Inflexible	Flexible
One stage, ramp-up period	Staged development possible
Suitable for large orebodies with consistent grade	Applicable to small orebodies with variable grade
Base metals, gold	Small orebodies of all metals, industrial minerals, rare earths
Centralized markets	Thin, end user markets
Large companies, global suppliers	Small companies, entrepreneurs, variety of suppliers

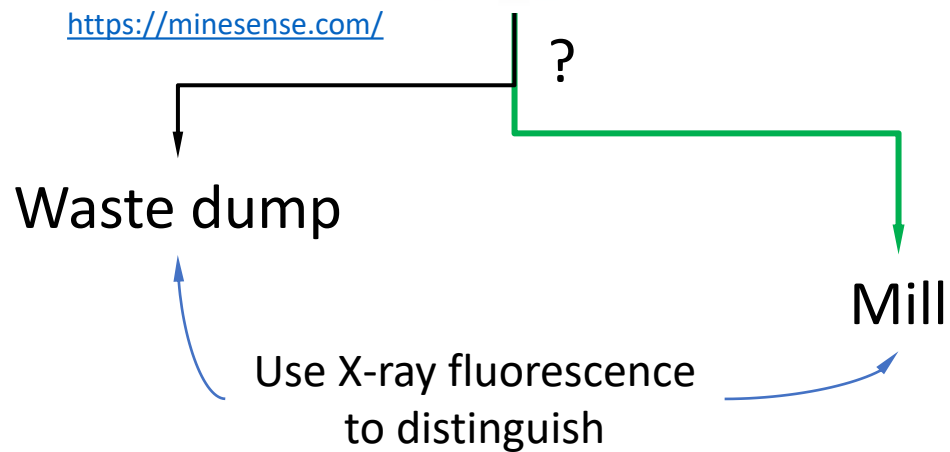
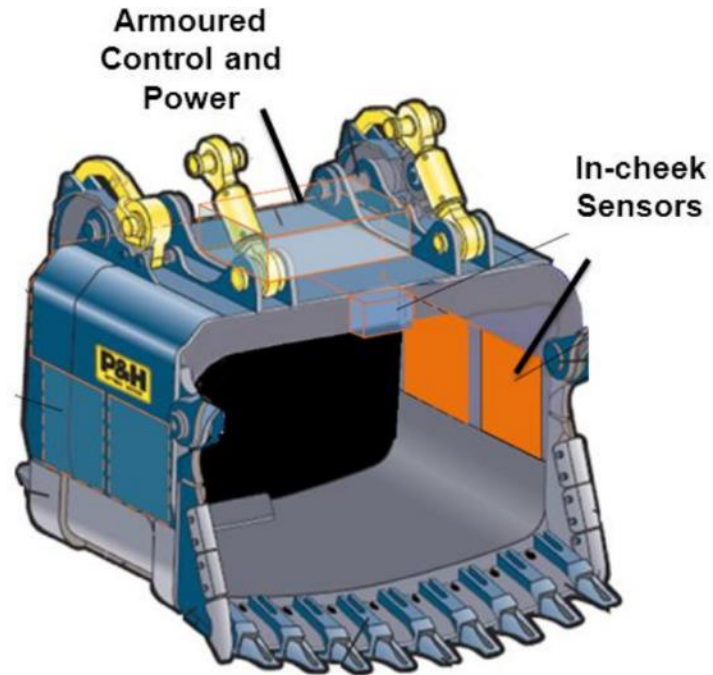
# Modular and mobile processing

[Modular Processing Solutions | Sepro Mineral Systems \(seprosystems.com\)](http://seprosystems.com)





# Ore sorting with a smart shovel



At HVC



<https://www.teck.com/media/Presentation-Slides-Investor-Day-April-2018-06-Innovation.pdf>



# Nechalacho Rare Earth Mine, NWT

Small operation  
100,000 t current mine plan  
Part of large deposit (~95Mt)



Density sorter  
uses X-ray  
transmission



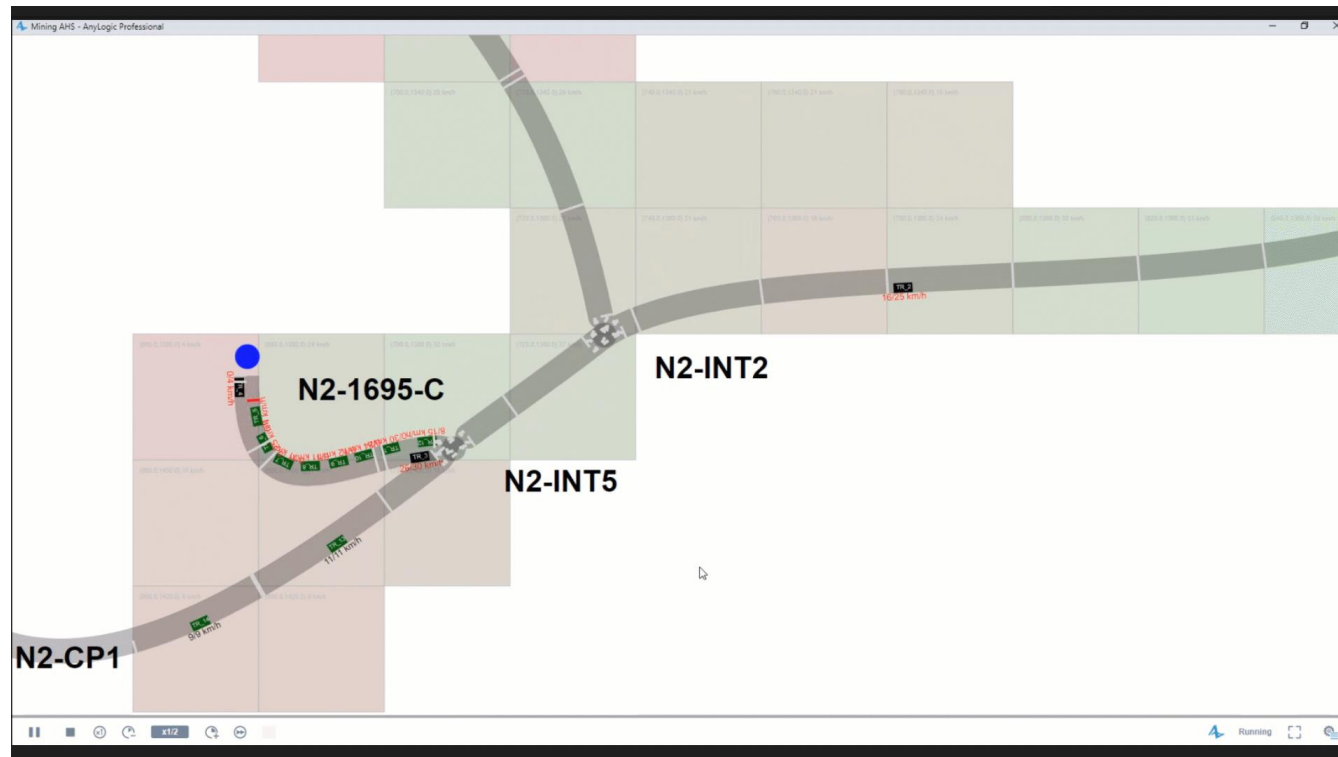
Bastnaesite  
(contains rare earths, dense)

Quartz  
(light)

15 tonne capacity – autonomous, electric



Large fleet of small autonomous trucks operates based on cues. Like an ant colony



# Microbes and minerals – a 2.5 billion year relationship

In every type of habitable environment on Earth

Microbes will either form or decompose minerals to produce carbon (food) or energy so that the microbe can survive and reproduce.

The result is an enormous amount of genetic information

A mineral microbiome

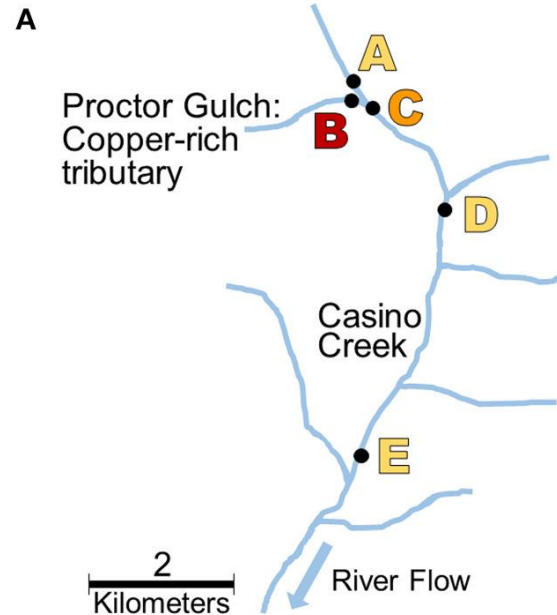
Can we exploit this information to extract metals?

Or to do remediation?



# Copper concentrations in Yukon river

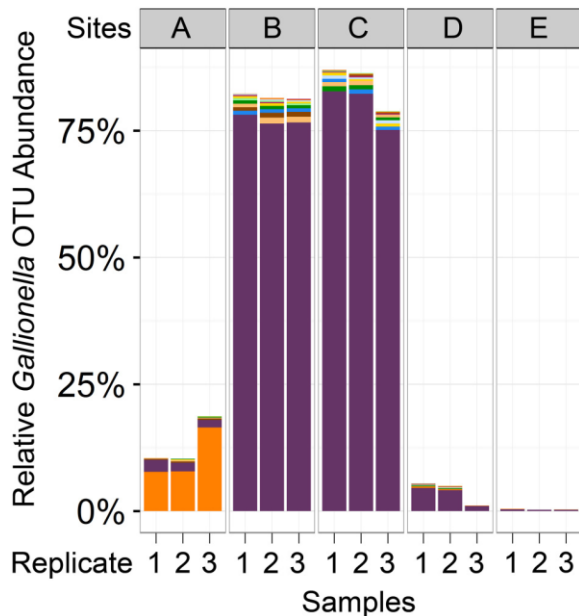
Site	Dissolved copper (mg/L)
A	0.10
B	0.96
C	0.35
D	0.02
E	0.01



B

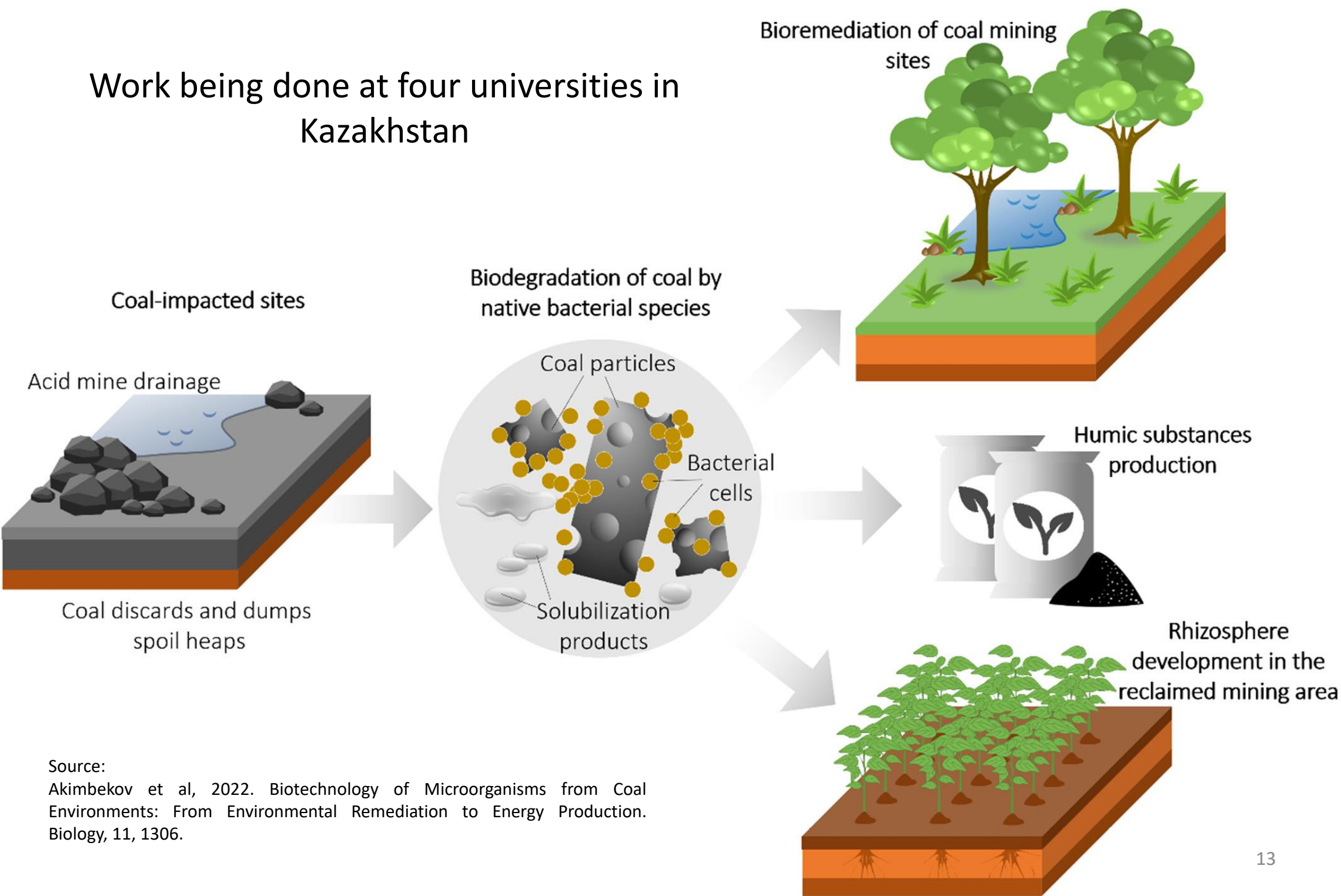


Three biofilm samplers in creek



The bacterium *Gallionella* has developed mechanisms to detoxify its environment by causing copper minerals to precipitate.

# Work being done at four universities in Kazakhstan



Source:  
Akimbekov et al, 2022. Biotechnology of Microorganisms from Coal Environments: From Environmental Remediation to Energy Production. Biology, 11, 1306.

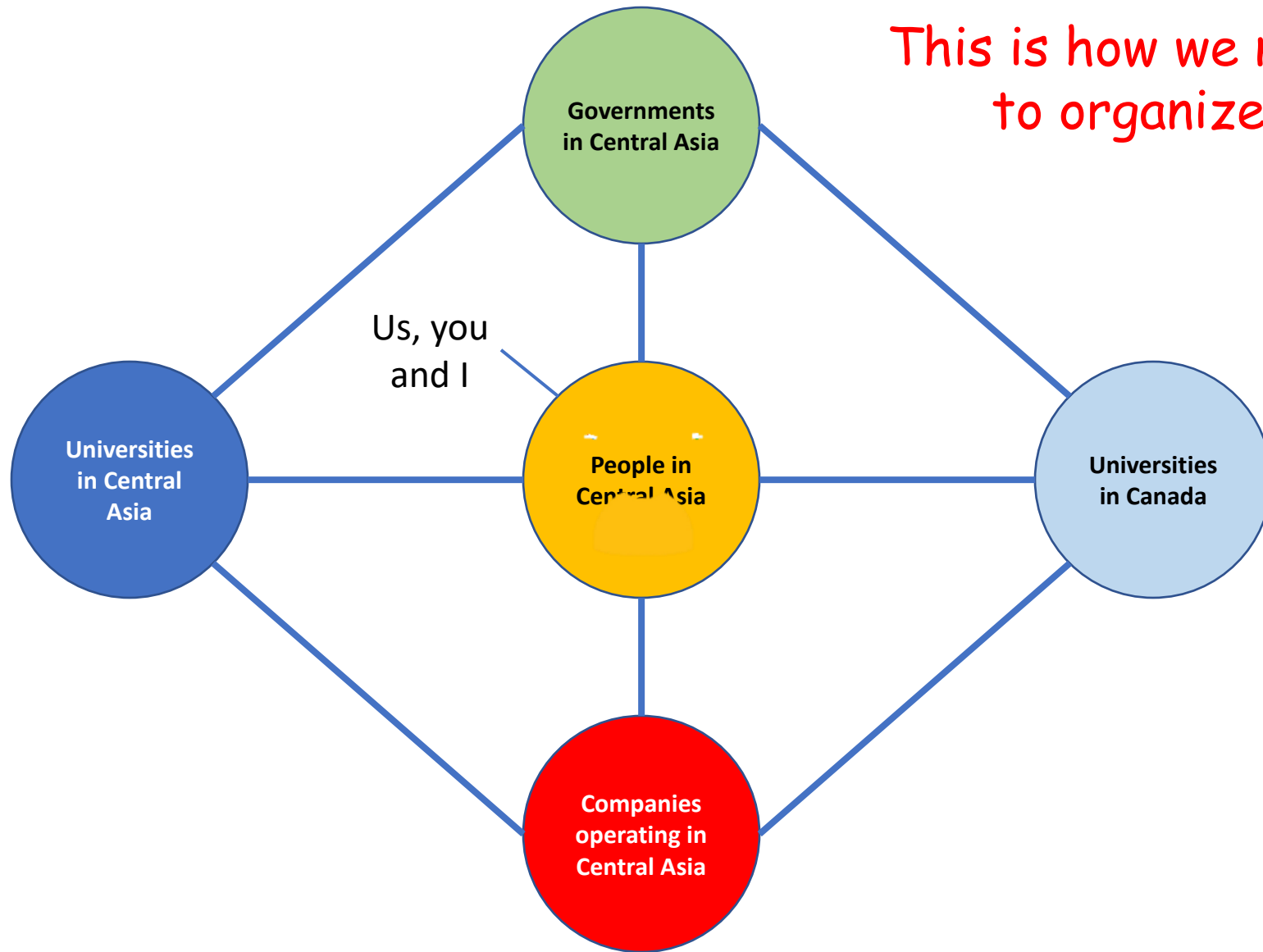
# MMAP – a GIU partnership

Sample mineral deposits. Find out what microbes are there?





**This is how we need  
to organize**



Thank you



# Drones and swarms



A drone towing a magnetometer

GEM Systems <https://www.gemsys.ca>

5G wireless test bed for mining applications

Ilija slide







