

An aerial photograph of a tailings storage facility (TSF) on a hillside. The facility consists of several large, rectangular, white tailings dams. The surrounding area is covered in green vegetation and trees. The sky is clear and blue.

Reimagining Collaborative Approaches to Tailings Research and Education: Strengthening Partnerships between Universities and Industry

Linda Ann Figueroa, PhD, PE, BCEE, MMSA QP

Director of the Tailings Center

Professor of Civil, Environmental & Mining Engineering

Colorado School of Mines

University Industry Partnership Highlights

1990s: Cotter Corporation

2000s: EPA Hazardous Substance Research Center

2010s: Freeport and Newmont

2020s: Tailings Center

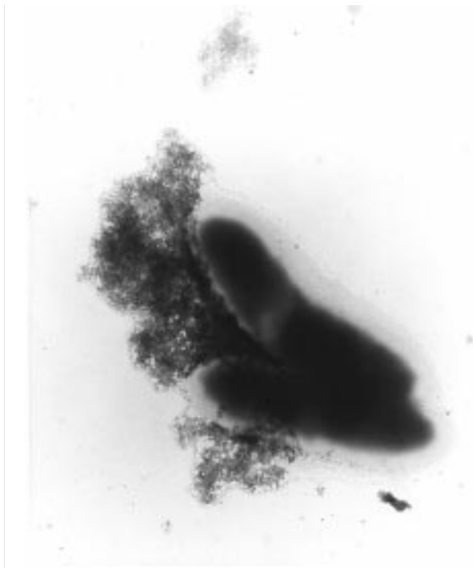


Cotter Corporation (1990s)

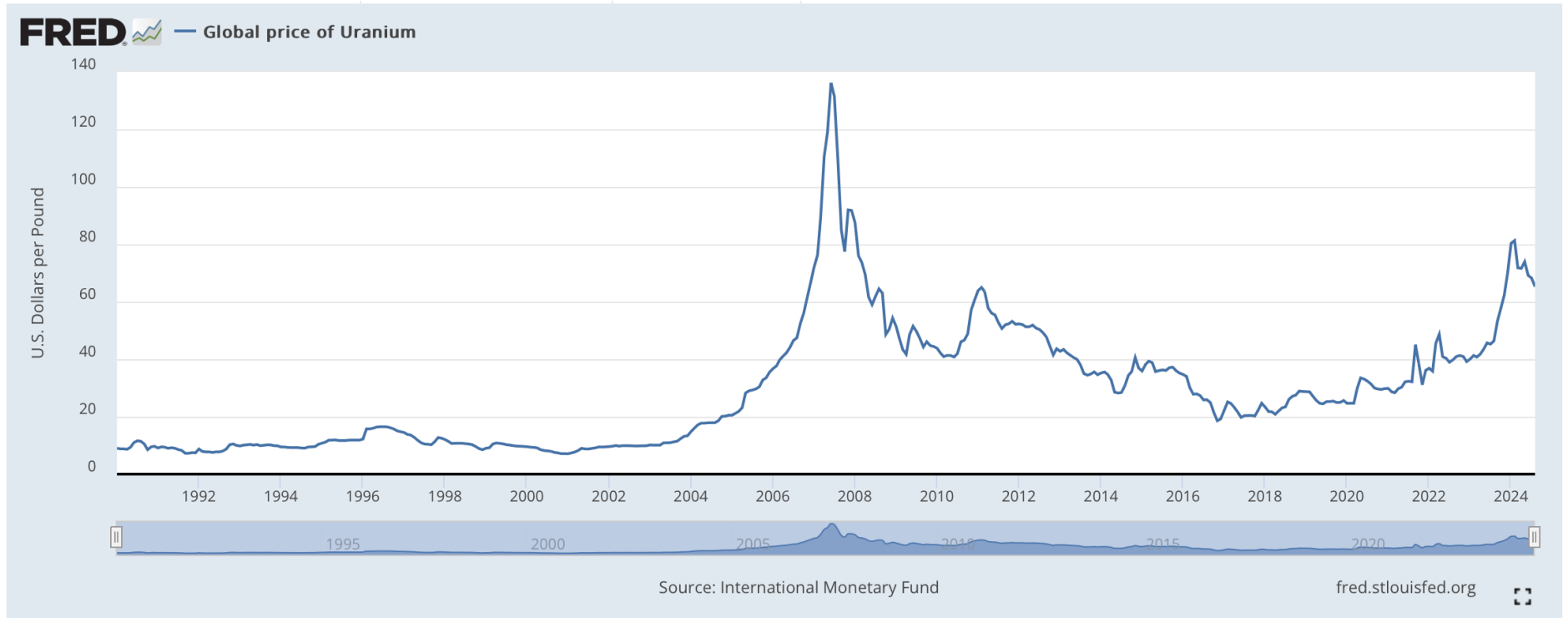
Schwartzwalder Mine

Operated 1950s-1990s

Bioremediation of uranium



Uranium Price History



EPA Hazardous Substance Research Center

Goal: to develop new and improve existing methods or technologies for remediation of mine waste sites that are cost effective and lead to clean ups that are protective of human health and the environment.

Consortium of participants from Colorado State University, Colorado School of Mines, and representatives from industry, regulatory organizations.

Operated from 2001-2006

EPA Program Discontinued

Lost Opportunity: Industry Partners hadn't been involved

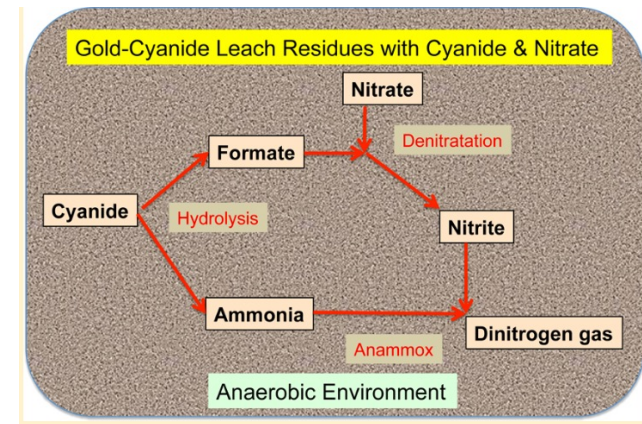
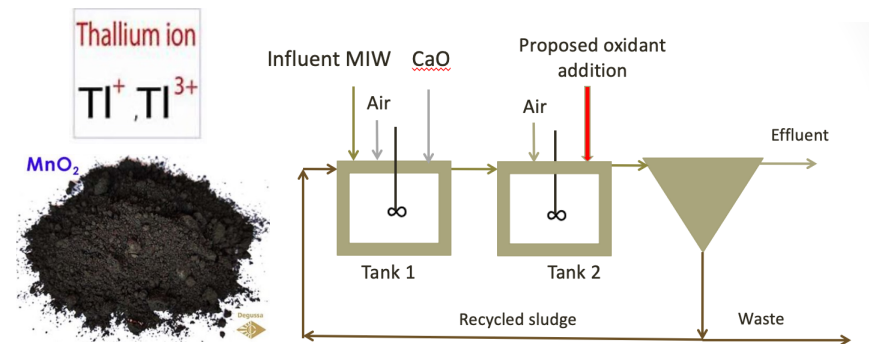


Newmont (2010s)

Center for Innovation in Earth Resources Science & Engineering (CIERSE)

Oxidative removal of thallium:
Experimental investigations to bridge
from proof of principle to practice

Biochemical controls on in- situ
anaerobic degradation of cyanide
in mining tailings

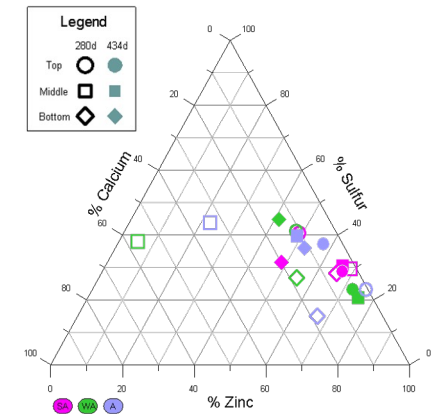


Gold Price History

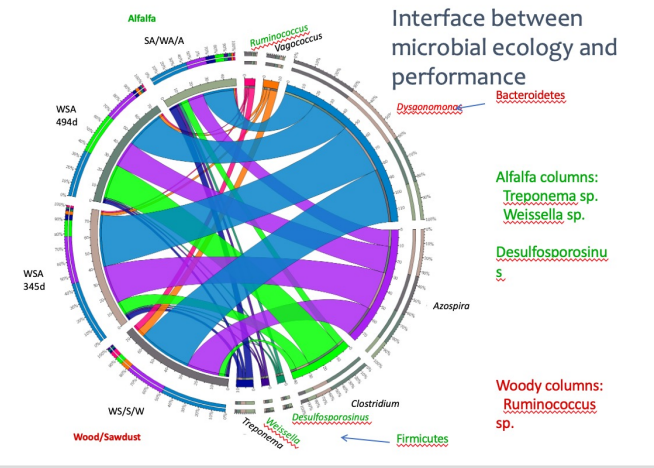
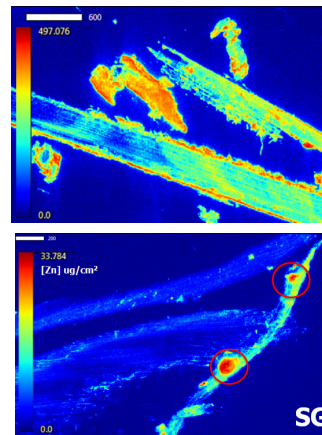


Freeport McMoRan (2010s)

Bioreactor treatment of mining influenced waters: Performance and monitoring tools



Integrated biogeochemical insights for enhancing bioreactor design



Copper Price History



Tailings Center (2020s)

The Tailings Center is an industry/university research and education center formed as a collaboration by the Colorado School of Mines, Colorado State University, and the University of Arizona with industry partners.





THE TAILINGS CENTER

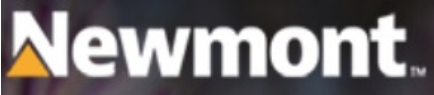
CREATING A SAFER TOMORROW

VISION: A trusted partner helping Industry enable best practices in closure and sustainability.

MISSION: To advance research, education and training in Tailings Stewardship

Teck Highland Valley Copper Operations, British Columbia
Courtesy of Teck Resources Limited

Our Founding Members



Tailings Center History

2020: MOU signed by the 3 University Partners partners

2021-2023: Professional development education, Recruiting

2023: Founding Membership Year, Assembled Industry Advisory Board, began Seed Research Projects

2024: Applying for Industry University Cooperative Research Center (IUCRC) Program

2025: Soliciting Research projects to meet the industry needs

Education

TAILINGS ENGINEERING GRADUATE CERTIFICATE

Why

The increasing demand for green energy technology is fueling the necessity for enhanced mineral extraction from the Earth leading to a **surge in tailings and mine waste** produced. To address future needs responsibly, it is crucial to **adopt environmentally and socially sustainable** practices, coupled with community-based solutions for tailings management. There is a large demand for qualified professionals to engage in the conscientious stewardship of tailings and mine waste.

Professional Development



Course 1: Fundamentals of Tailings Engineering

Tailings generation, characterization continuum, operations and geotechnics, innovation and minimization.



Course 2: Planning, Siting and Design Concepts

Factors impacting TSF planning and siting, facility types and components, Construction and operations, planning and siting, site investigations and sampling.



Course 3: Geotechnical Design, Instrumentation & Monitoring

Design, stresses and pore water pressure monitoring, loading conditions, stability analyses, performance monitoring and inspections.



Course 4: Water Management

Hydrologic considerations, management, water balances, geochemical consideration, water quality and leaching, seepage, performance and regulatory processes.



Course 5: Operation and Governance

Tailings Stewardship, management systems, operation, maintenance, and surveillance, monitoring systems and data analysis, risk management and emergency action plans, international standards.



Course 6: Closure and Reclamation

Decommissioning closure planning, monitoring, cost estimates, environmental liability, and financial assurance.

2023 Seed Research projects Funded by Membership

Mines

Tailings Reduction Through Sustainable Reuse as Construction Materials

CSU

Geotechnical Insights from Legacy Tailings Facilities

UofArizona

Tailings Cover Material: Biophysicochemical Properties Associated with Successful Plant Establishment



Production of Lightweight Aggregates from Tailings

Leveraging additional funding from our partners



Latest Success: Reusing Tailings in Colorado

Colorado Office of Economic Development and International Trade

The grant provides funding to help Colorado research institutions with applied research in advanced industries and to commercialize products and services in the private sector

Phase I: Proof of Principle (evaluate the technology commercial potential)

Technology: Process for light weight aggregate production from tailings

Source: Tailings samples from Climax Molybdenum a Freeport McMoRan Co.

Currently: Applying to US Gov Funding



IUCRC
*A Collaborative
Partnership*



Government

NSF catalyzes partnership; other agencies join as Members or co-fund the Center



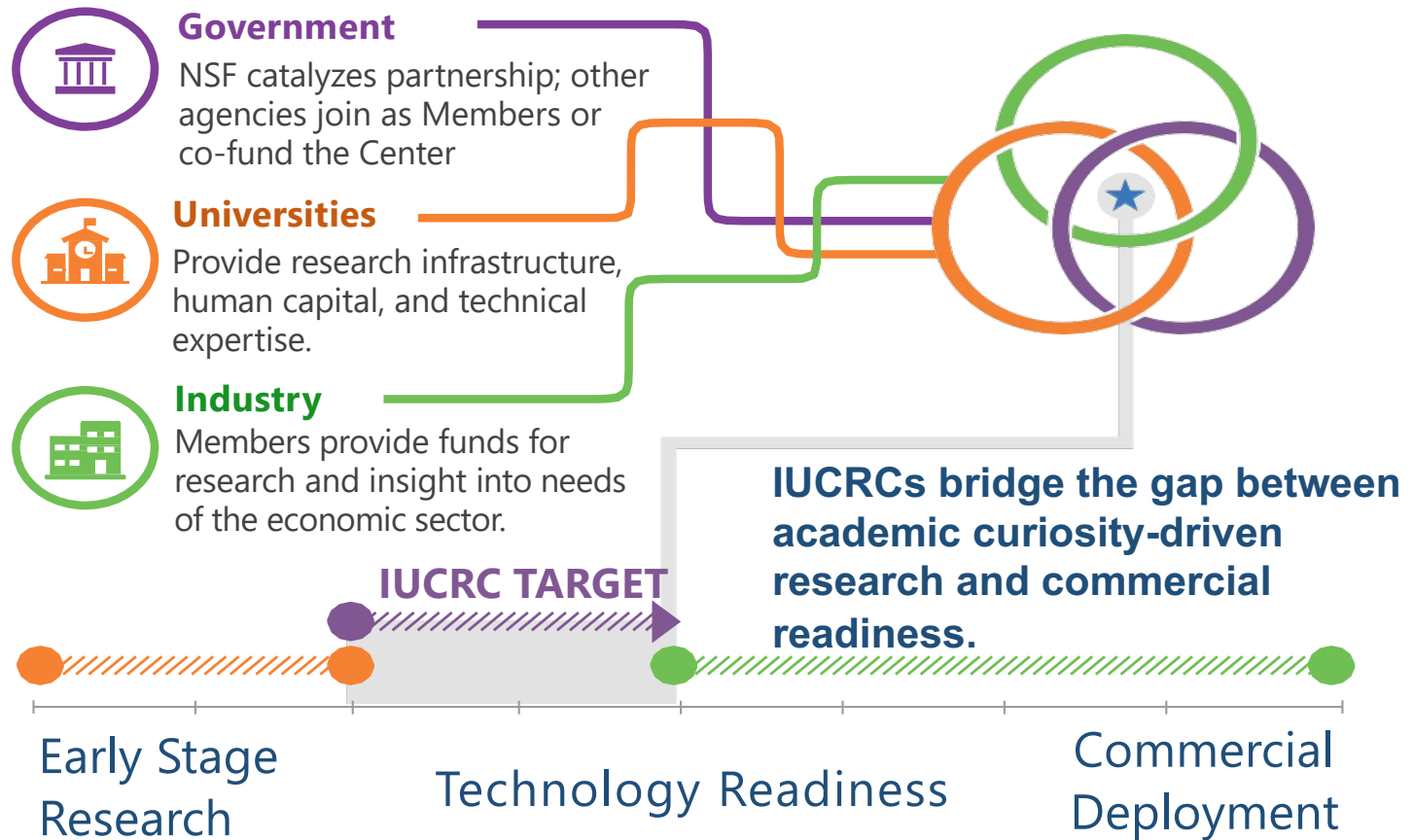
Universities

Provide research infrastructure, human capital, and technical expertise.



Industry

Members provide funds for research and insight into needs of the economic sector.



IUCRCs bridge the gap between academic curiosity-driven research and commercial readiness.

Early Stage
Research

Technology Readiness

Commercial
Deployment

Industry University Cooperative Research Center

The Tailings Center: Takeaways

Our Goal: Long-term, sustainable home for Innovating Tailings

- The Tailings Center & Mines - a home for **continuity** and implementation
- Tailings are hot NOW, but when they cool down, let's keep momentum!
- Opportunity NOW to access \$Millions US Gov – need industry support.

Our Vision: Breaking Silos in Tailings Innovation Ecosystem

- Enabling outside innovation from academia and startups
- ICMM members leading the way on closure - WE can disseminate to industry
- Leveraging the trust & experience built over decades



Tailings Center

CREATING A SAFER
TOMORROW

tailingscenter.com

tailingscenter@mines.edu

Director: Linda Figueroa
LFiguerola@mines.edu