High-Pressure Slurry Ablation (HPSA) – A New Liberation Technology

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TECHNOLOGY FOR MINERALS PROCESSING AND REMEDIATION FOCUSED ON:

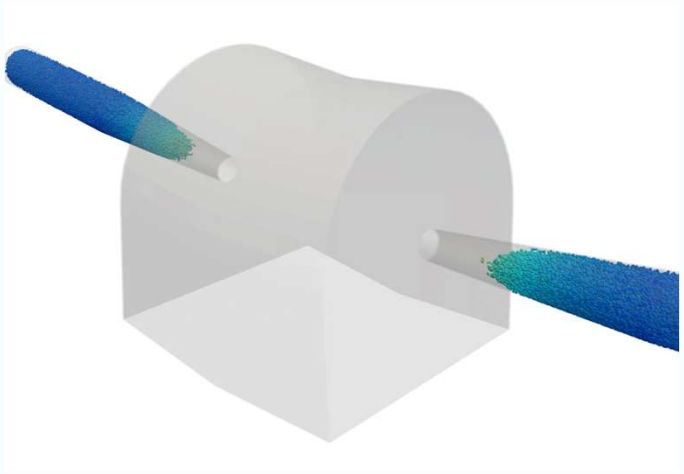
INCREASING RECOVERIES

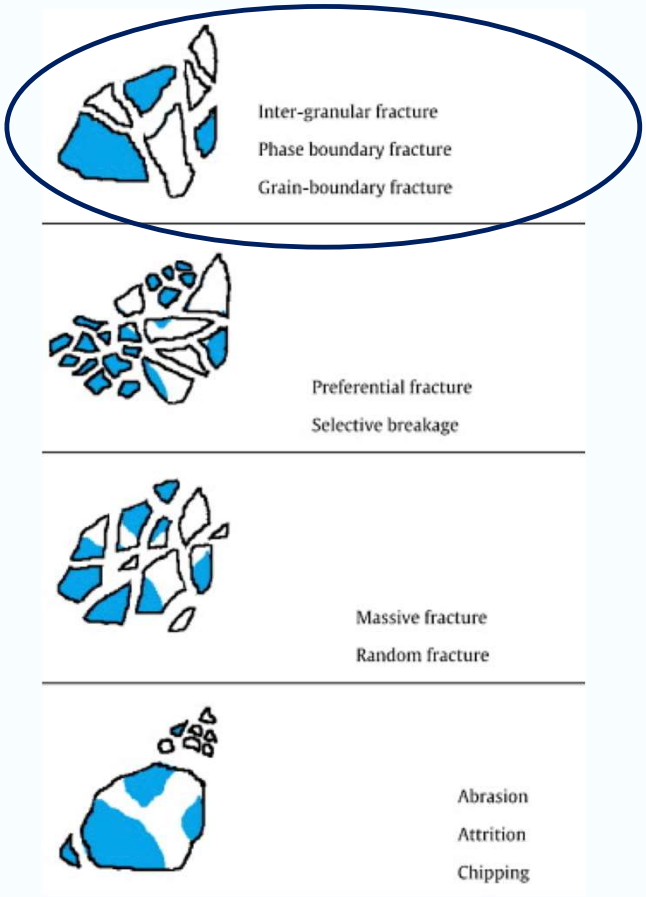
NEUTRALIZING WASTE

CONCENTRATING CRITICAL MINERALS

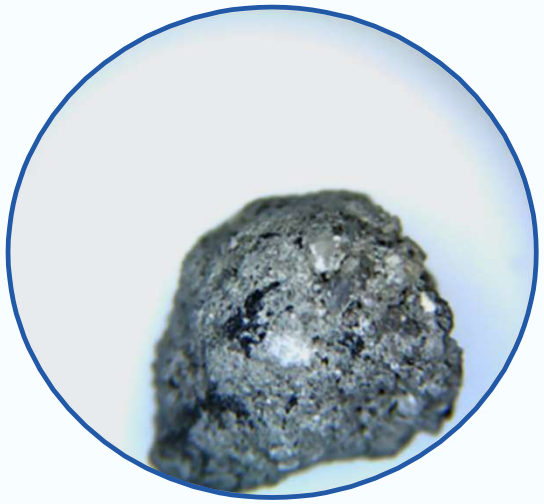
TECHNOLOGY OVERVIEW

- **High-Pressure Slurry Ablation (HPSA)**
  - Slurry formed with feed material and water
  - Mechanical process creating particle-particle collisions
  - Creates an intergranular fracture using the intrinsic material properties.





SELECTIVE LIBERATION



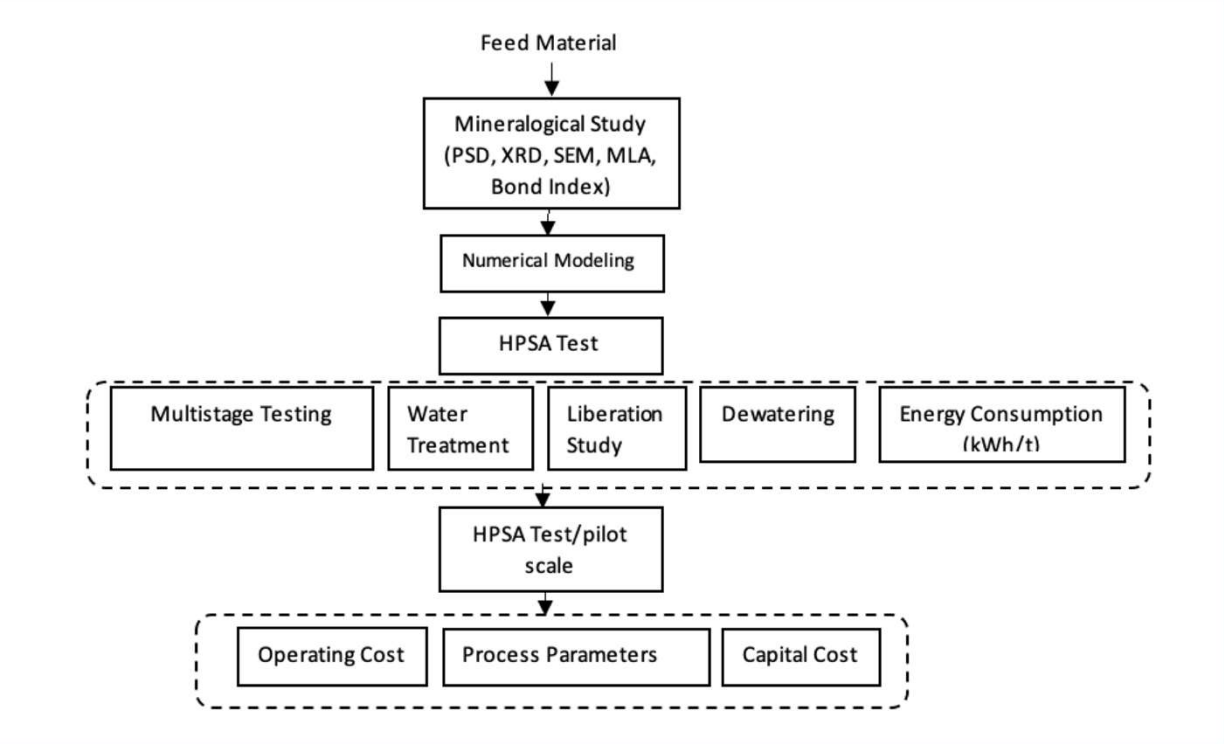
Sand grain is heavily coated with Uranium and Vanadium minerals

Particle-particle collisions allow for efficient Uranium and Vanadium separation

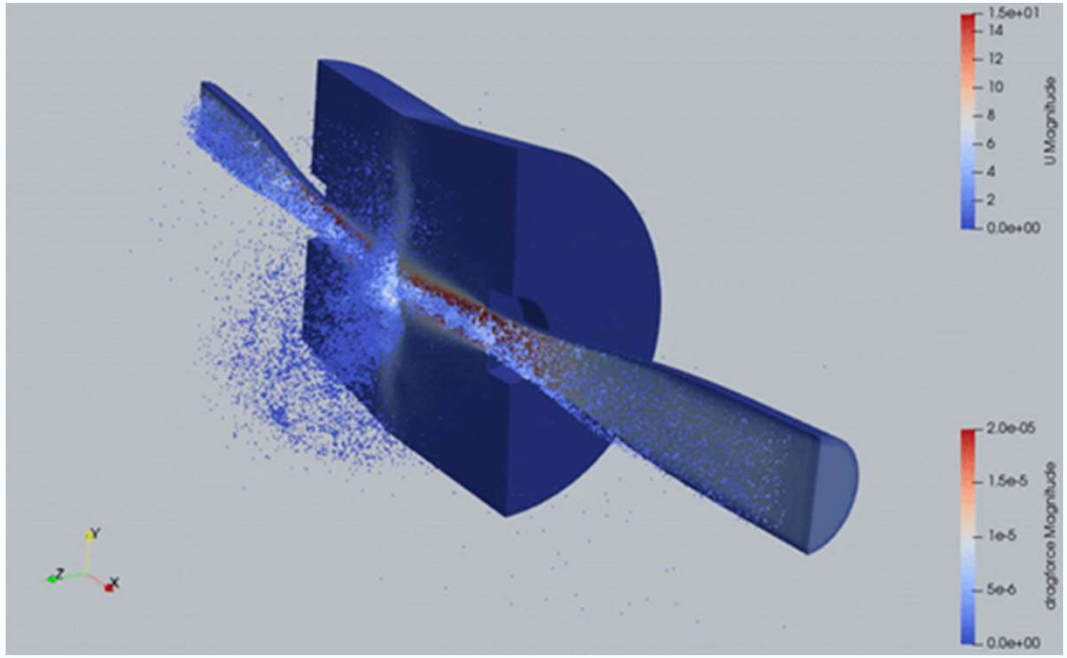
Coating is completely removed yet the sand grain remains intact

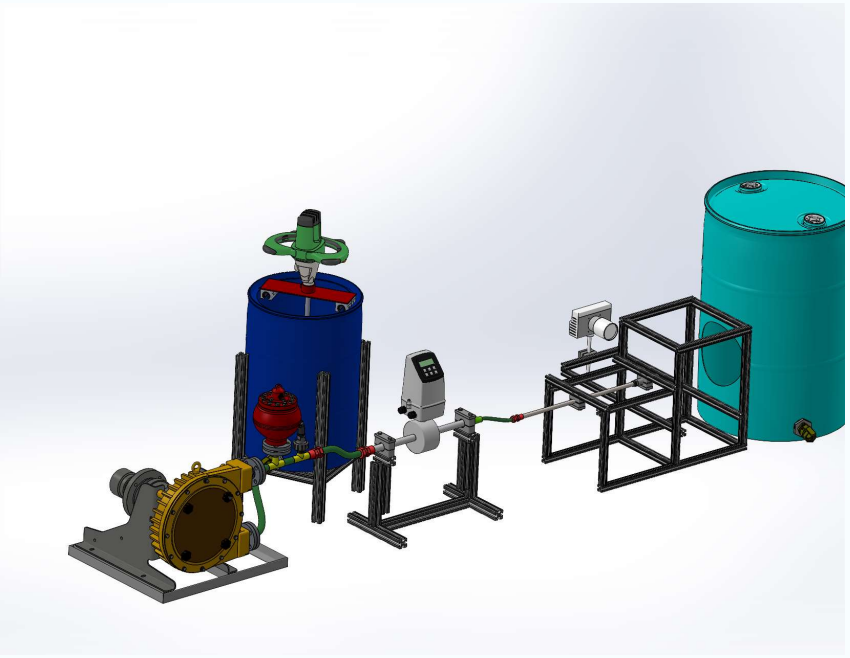
TECHNOLOGY OVERVIEW

DESIGN OF EXPERIMENTS



CFD OPTIMIZATION





Credit – Dustin Weaver (UBC PhD Student)

TECHNOLOGY DEVELOPMENT

Concept Validated
TRL 3*

Pilot Units (6)

COMPLETE

2018 Q3

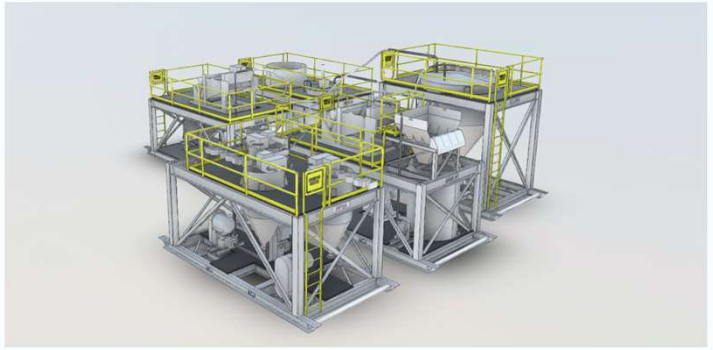
Capacity Validated
TRL 6

GEN ALPHA

COMPLETE

2019 Q3

Continuous Operations
TRL 8/9



GEN BRAVO

COMPLETE

2023 Q1

*TRL= Technology Readiness Level

ALTA 2023 27
30 April - 6 May | Perth, Australia

URANIUM REMEDIATION

Remediation of waste piles and contaminated materials at abandoned mines and other sites

Over 15,000 abandoned uranium mines (or waste piles) in the Western United States

Many of these waste piles are on or near tribal locations

Approximately 1 in 5 people in the West live within 50 miles from an abandoned uranium mine

Most of these waste piles:

Created over 4 decades ago	Sit on the surface where uranium has oxidized	Limits use of the land	May cause dose and contamination issues

Uranium Remediation Options

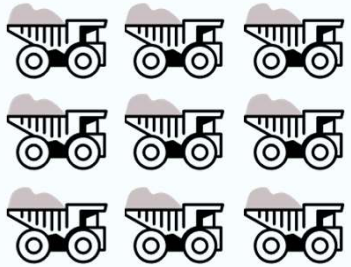
15,000+ Uranium waste piles with 500,000+ tons of uranium

The potential to fuel the entire U.S. civilian reactor fleet for over two decades

02

ONLY ALTERNATIVE

Transport 100% of Material to a Milling Facility



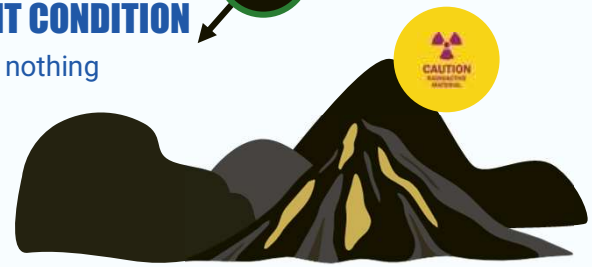
Up to 9x

carbon, traffic, cost, and tailings disposal cells

01

CURRENT CONDITION

Do nothing



03

HPSA Solution

HPSA processing onsite

- **90%** of material reclaimed onsite
- **10%** of material recycled to mill
- Provides U3O8 to Nuclear Fuel Cycle
- Fuel for carbon-free electricity

90%

10%

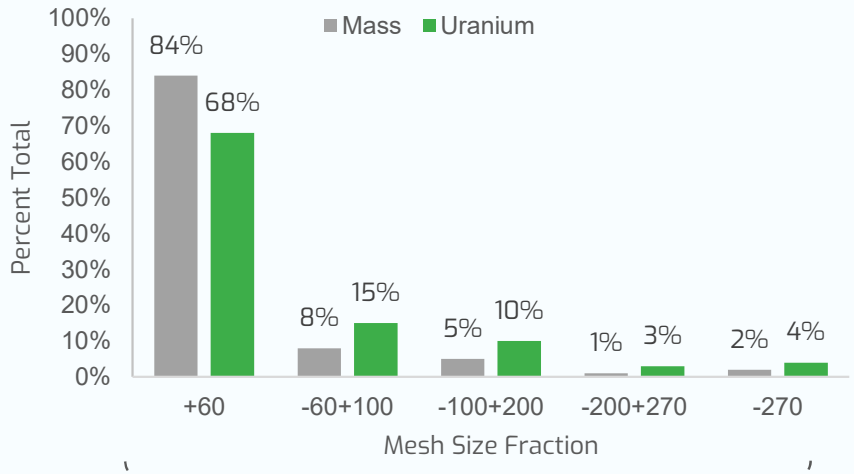
Safe Sites

Carbon-Free Energy

ENVIRONMENTAL, RECYCLE & ECONOMIC SOLUTIONS TO PROMOTE CLEANUP AND INCREASE URANIUM RECOVERY

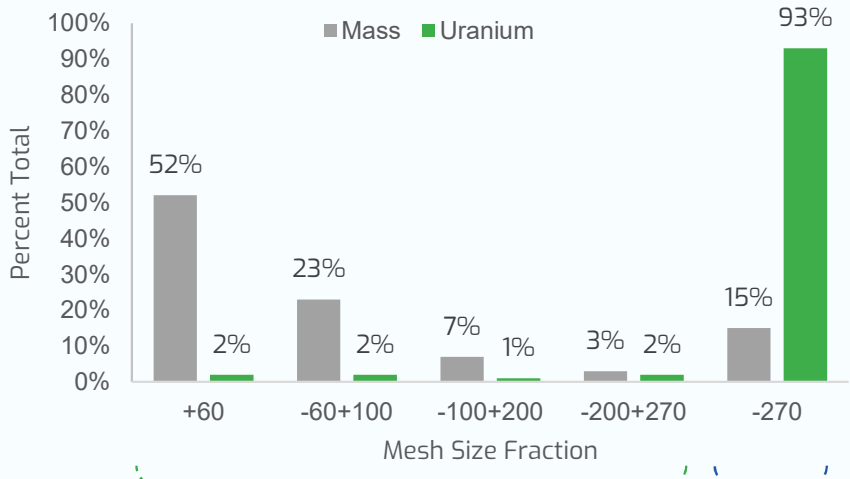
URANIUM REMEDIATION

Before HPSA



Uranium is present across the mass profile

After HPSA



Uranium levels are low enough in remaining 85% of mass to remain on-site

93% of the Uranium is present as a saleable product in just 15% of the total mass

MINE WASTEROCK EXAMPLE

Site Location – Western Colorado

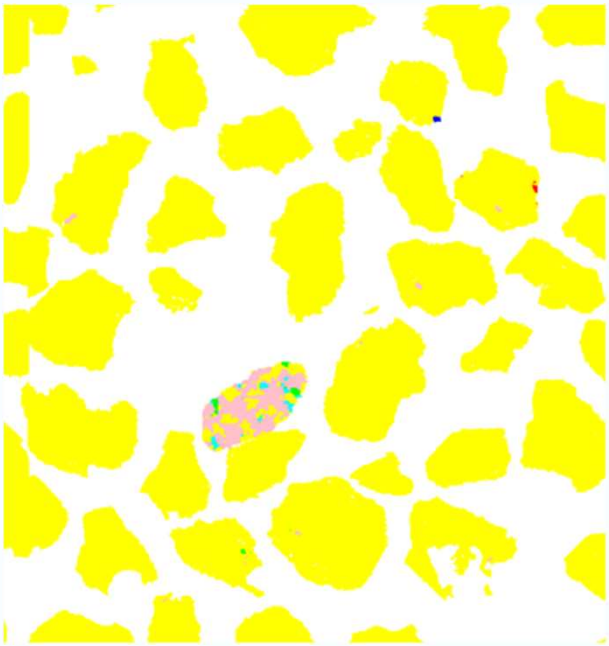
RADIOLOGICAL & MINERALOGICAL COMPONENTS

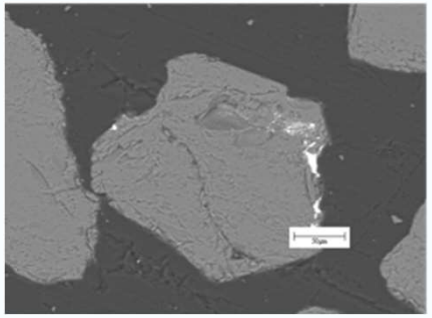
Parameter	Units	Waste Rock	Clean Coarse Fraction	Total Reduction	Percent Reduction
Lead 210	pCi/g	149	37.1	111.9	**75.10%**
Radium 226	pCi/g	125	70.4	54.6	**43.68%**
Radium 228	pCi/g	1.9	1	0.9	**47.37%**
Thorium 230	pCi/g	153	74.7	78.3	**51.18%**
Thorium 232	pCi/g	ND	ND	NA	NA
Vanadium	mg/kg	1,362	409	953	**70%**
Uranium	mg/kg	912	129	782	**86%**

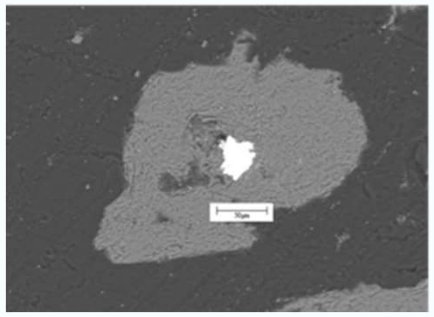
HPSA Reduces the Overall Radiological Signature

MINERAL LIBERATION ANALYSIS RESULTS

MLA demonstrates that the clean coarse fraction is stable







Mineral	Color
Albite	
Apatite	
Calcite	
Carnotite	
Chlorite	
Dolomite	
Illite	
Oligoclase	
Orthoclase	
Quartz	
Zircon	

+100-mesh: 51.3% of total mass, 130 ppm U, **0.00% Leachable**

SYNTHETIC PRECIPITATION

Parameter	Units	Waste Rock	Clean Coarse Fraction	% Difference
Arsenic	mg/L	0.664	0.148	**78%**
Lead	mg/L	0.014	0.006	**57%**
Selenium	mg/L	0.020	0.006	**70%**
Uranium	mg/L	0.10	0.06	**40%**
Vanadium	mg/L	0.57	0.14	**75%**
Lead 210	pCi/L	9.9	6.2	**37%**
Radium 226	pCi/L	20.0	9.8	**51%**
Radium 228	pCi/L	ND	ND	NA
Thorium 230	pCi/L	7.4	4.0	**46%**
Thorium 232	pCi/L	ND	ND	NA

POST-REMEDIATION CLEAN COARSE FRACTION DOSE

Individual Type	Hours/ Day	Months	Total Days	Total Hours
Public	8	6	180	1440

Case	Type	Dose Rate (mrem/hr)	Annual Dose (mrem/yr)	Dose Limit (mrem/yr)	% of limit
Maximum[a]	Public	0.006	**8.8**	25[b]	35.2%
	[a] Maximum dose occurred at the closest modeled distance, 0.1 m, from the surface of the source volume. [B] Unrestricted release limit				

Maximum Public Exposure to Clean Fraction is Well Below Regulatory Limits

NAVAJO NATION STUDY

- Significantly higher rates of cancer and kidney failure on Navajo Nation
- 85% of homes contaminated with uranium
- 523 Sites with EPA cleanup funds

Is HPSA effective?

Reduced contamination by up to 98%

Is HPSA economic?

50 – 80% cheaper than current alternative

Does HPSA work on a variety of materials?

Successful at 3 different sites on Navajo Nation

*Supported by US EPA and Navajo Nation EPA

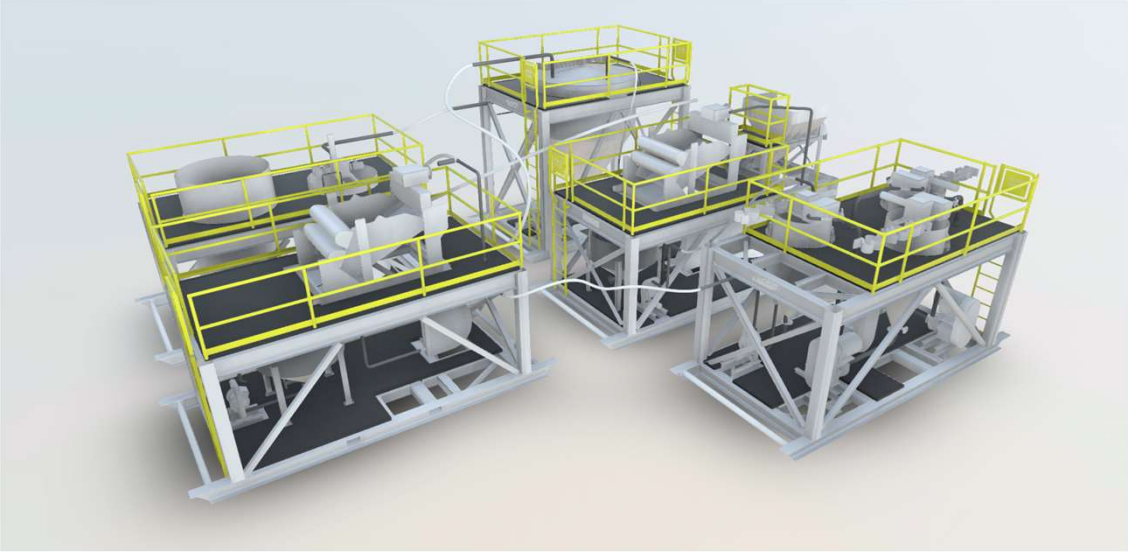
PUBLIC POLICY & BENEFIT

Waste Remediation -

- Return mine sites to useable recreational areas
- Reduce radiological signatures to ALARA
- Disposal of concentrated materials addresses long-standing environmental justice concerns

HURDLES TO REMEDIATION

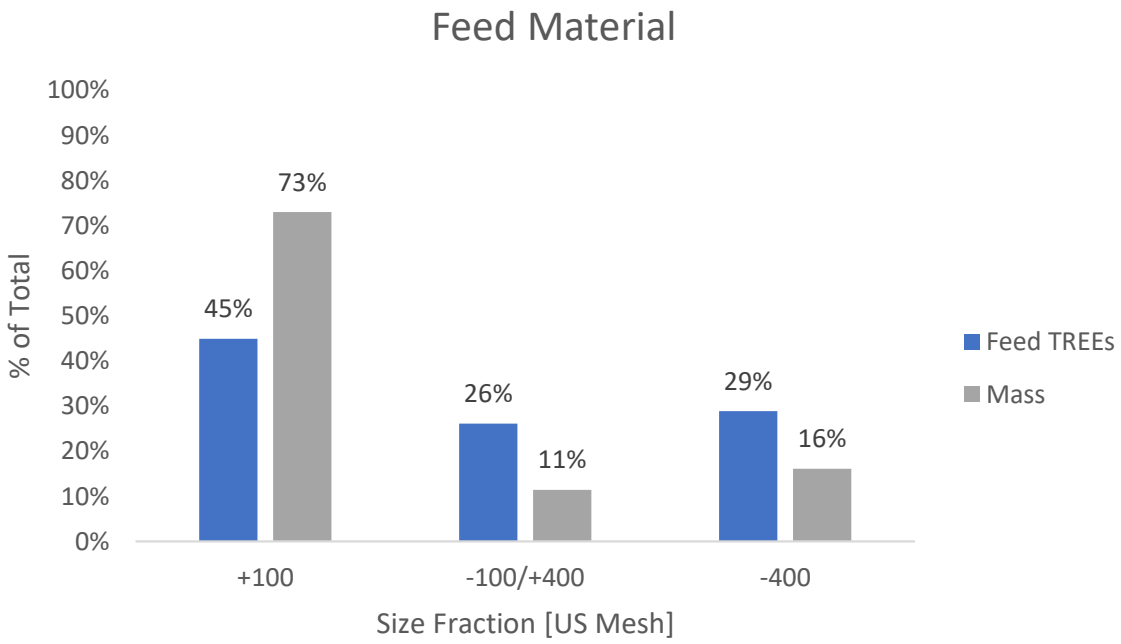
- Regulators understanding how to license innovative technology
- Operating technology at scale (Gen Bravo)

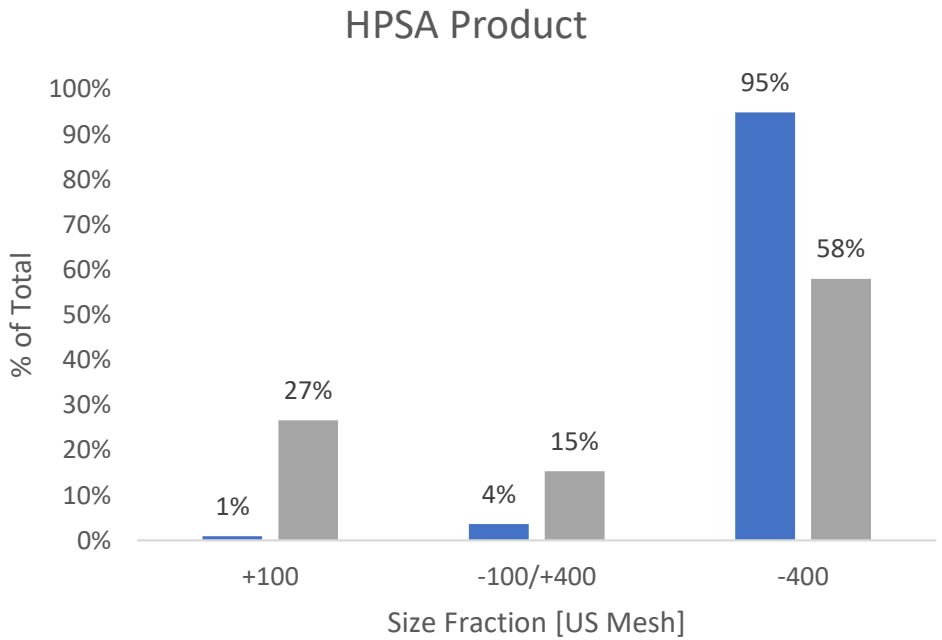


TRADITIONAL MINERALS PROCESSING CIRCUITS

RARE EARTH ELEMENTS

- HPSA processing improved concentration of the TREEs from 29.0% in the Feed to 95%





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PHOSPHATE

- Pilot unit installed in November 2022
- Provides ability to test HPSA technology on various parameters

PHOSPHATE

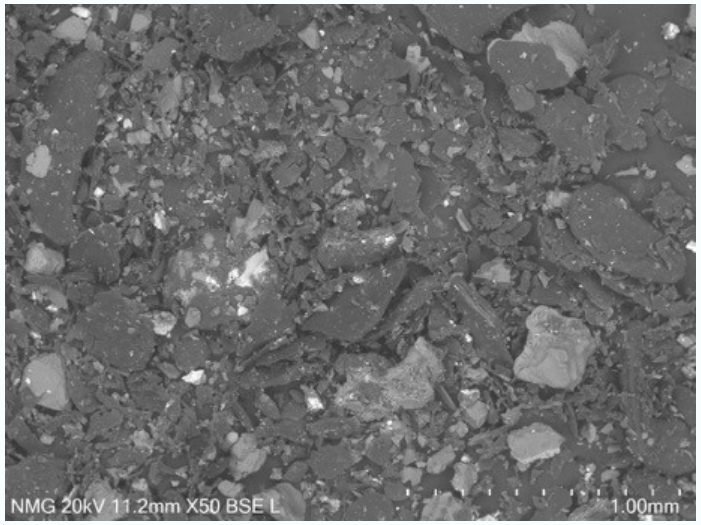
ROD MILL

- Legacy equipment, underperforming with current orebody characteristics

HPSA PILOT UNIT

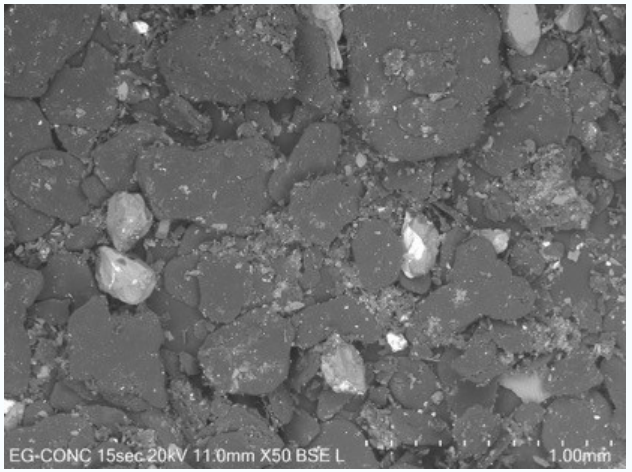
- HPSA product grade increased by almost 5% while increasing recovery by nearly 3%
- Also reduced gangue material in product

GRAPHITE

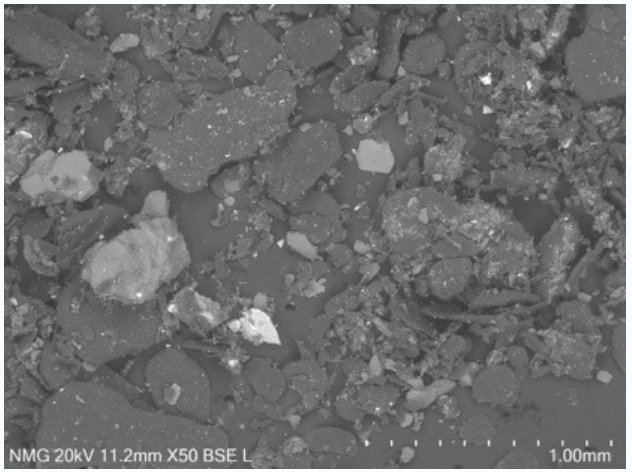


Current Process
Rougher Flotation
Grade – 55%
Recovery – 96%
P_{80} = 350 µm

HPSA Test 1
Rougher Flotation
Grade – 74%
Recovery – 94%
P_{80} = 372 µm



HPSA Test 2
Rougher Flotation
Grade – 80%
Recovery – 96%
P_{80} = 352 µm



- Post process flotation concentrate showed increased grade
- Replaces current ball mill prior to rougher flotation step and associated OPEX

ENERGY CONSUMPTION

- HPSA process benchmarked against traditional milling applications
- HPSA not only reduces energy consumption, but can displace multiple unit operations

Current Process

- Size reduction of ROM Ore
- Concentrator Circuit with Ball Mill to Increase Grade to 55%
- Post-Concentrator Circuit
  - 1 Polishing Mill
  - 8 flotation banks
  - 2 attrition cells
  - 2 column flotation cells
  - To achieve 95% purity product

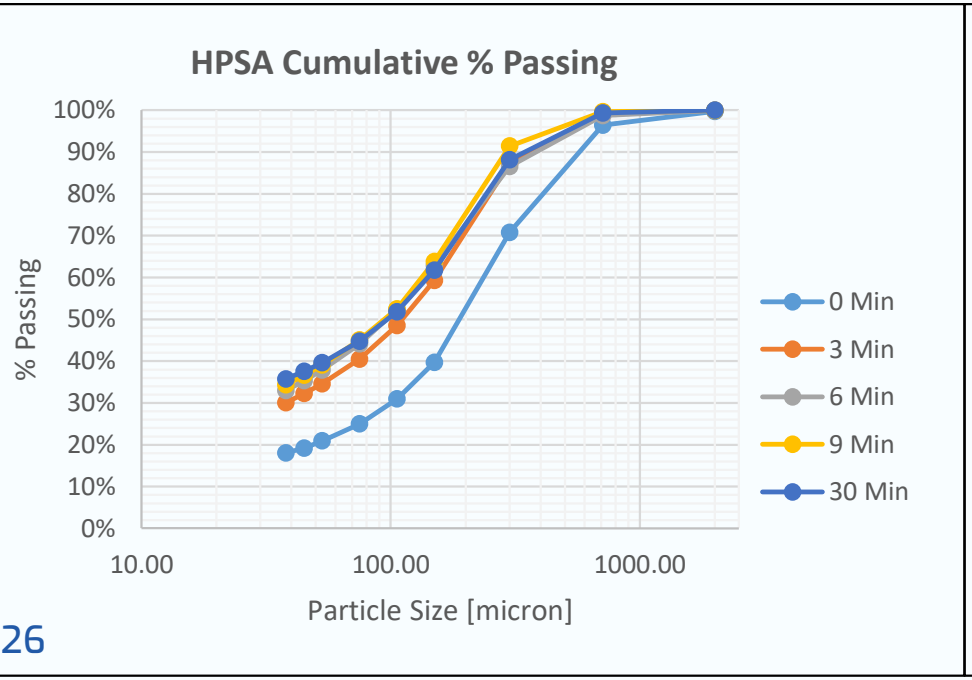
With HPSA Installed

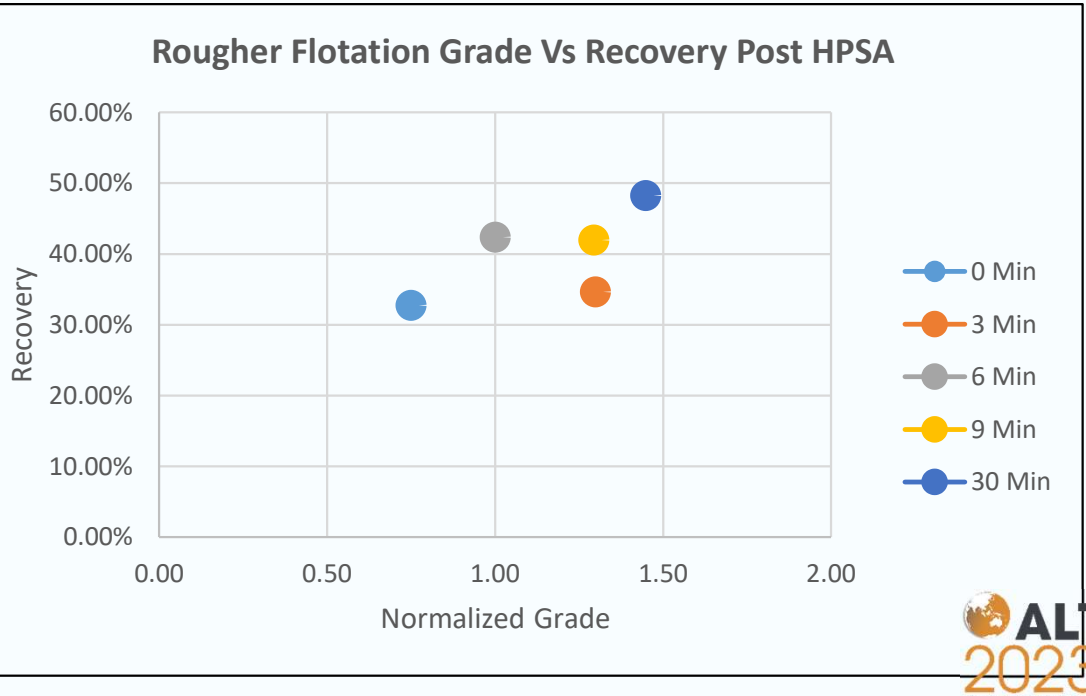
- Size reduction of ROM Ore
- Concentrator Circuit with HPSA to Increase Grade to 75+%
- Post-Concentrator Circuit
  - 1 Polishing Mill
  - 4 flotation banks
  - 1 attrition cells
  - 1 column flotation cells
  - To achieve 95% purity product

- For a 250 TPH unit, Disa's model indicates 1 – 3 kWh / ton energy consumption

GOLD TAILINGS

- After HPSA processing, the rougher flotation concentrate grade nearly doubled and recovery increased by over 15% when compared to the current flotation process.





Thank you!

www.DisaUSA.com

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