

Mining Foundation Distinguished Lecture

Thursday, April 27, 2017

A Rocky Mountain Hi!

Presented by

Mr. John G. Mansanti

2017 President - The Society for Mining, Metallurgy and Exploration

Reception from 5:00-6:00 p.m.
Marriott Griffin Gate Resort - Lexington, Kentucky
Lecture begins at 6:00 p.m.

Reception Sponsored by Steinert US, Inc.



John G. Mansanti is the Senior Vice President of Strategic Initiatives and Technical Services for Intrepid Potash, Inc. Prior to joining Intrepid he had over 30 years of operations management experience in precious and base metals, managing several of the flagship gold properties in Nevada including Goldstrike, Cortez and Carlin. As a result of mergers and acquisitions he worked for many gold companies most notably Barrick, Placer Dome, Newmont and Freeport. In addition to his experience in the potash and precious metals industries he has process experience with copper, molybdenum, lead and zinc. He has managed open pit, process and underground operations.

Mansanti is currently the 2017 SME president. Throughout his career Mansanti has been recognized within SME as MPD's Outstanding Young Engineer, a Robert H. Richards Award recipient and a SME Distinguished Member. Mansanti has also been recognized by the Department of the Interior and in 2012 he was awarded the Director's Excellence Through Leadership Award.

He is a graduate of the Montana College of Mineral Science and Technology with degrees in Chemistry and Mineral Processing Engineering. Mansanti is a registered professional engineer.

He and his wife Margi recently celebrated 35 years of marriage. They have three children, two sons-in-law, five grandchildren and one dog.



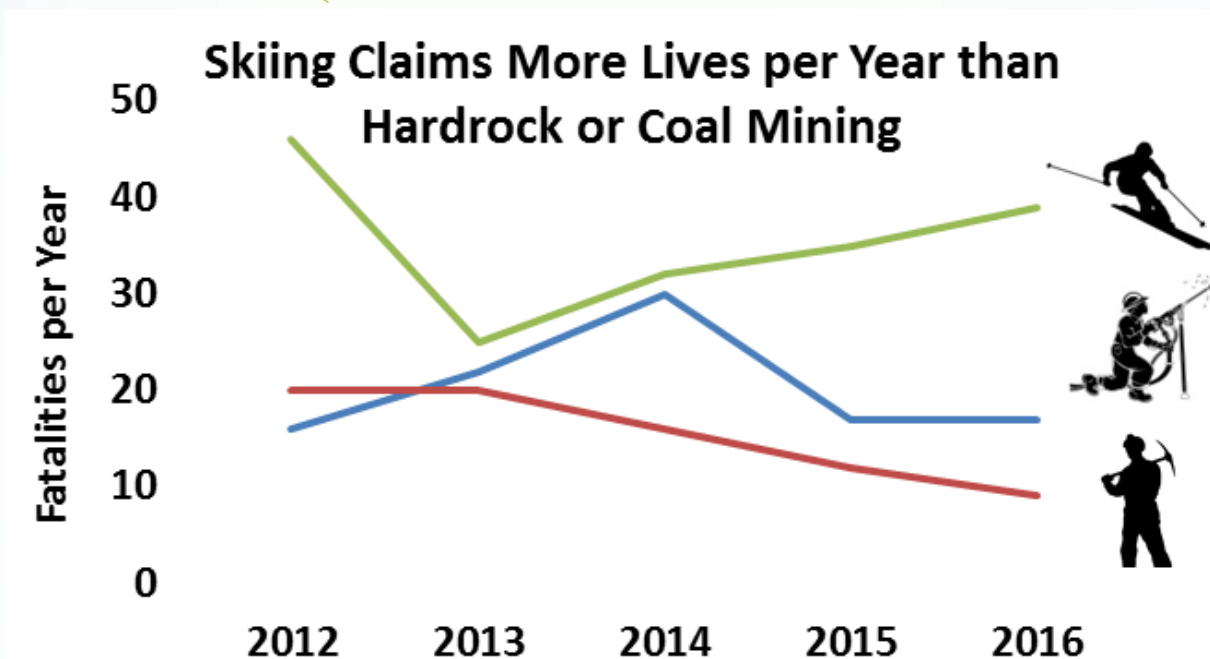


Evaporation Ponds in
Carlsbad New Mexico

April 27, 2017
University of Kentucky
Mining Engineering Foundation

A Rocky Mountain Hi!
John Mansanti 2017 SME President

Another Perspective



MSHA Recorded Fatalities	1916 Fatalities	1917 Fatalities	2017 Fatalities	2017 Rate*
Metal Nonmetal	870	938	17	7.2
Coal	2,226	2,696	9	11.0
Total	3,096	3,634	26	8.2

* Rate as Fatalities per 100,000 miners employed

SME



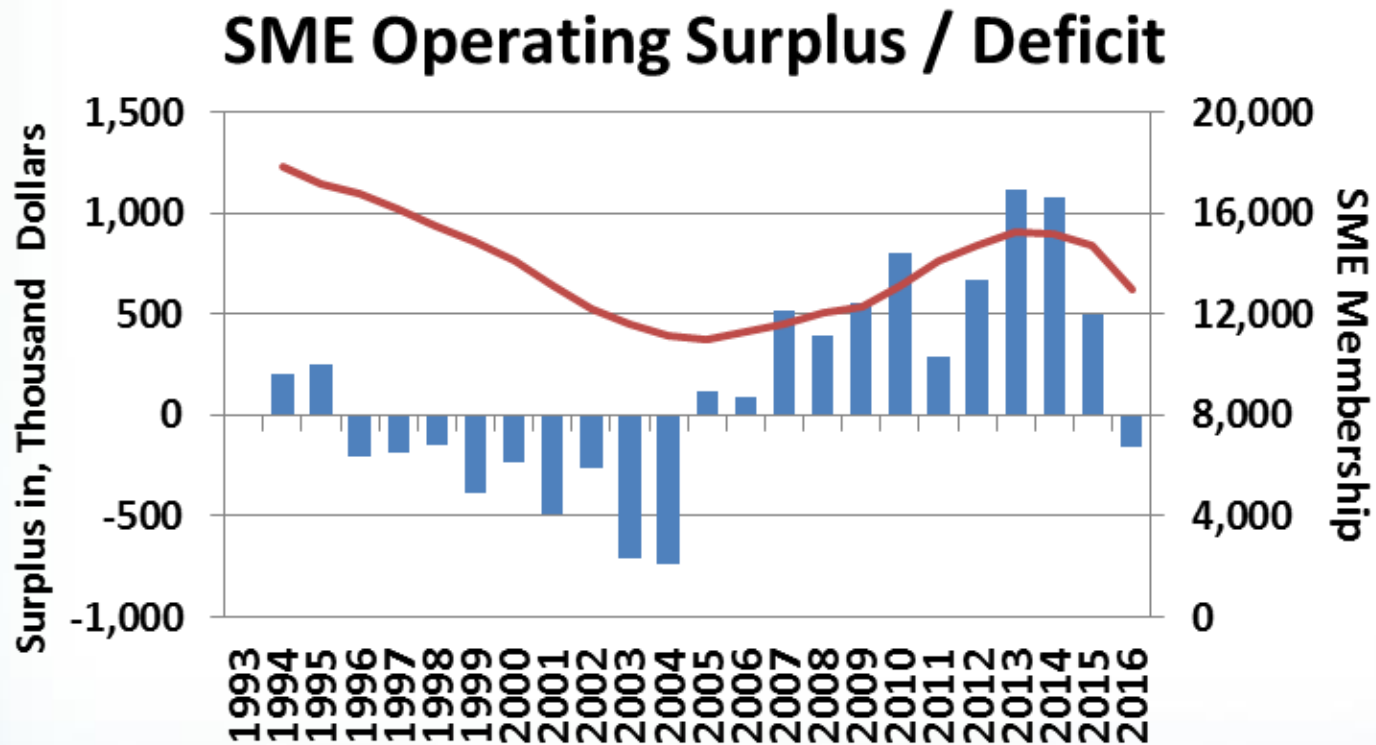
SME



Key SME Focus Areas for 2017

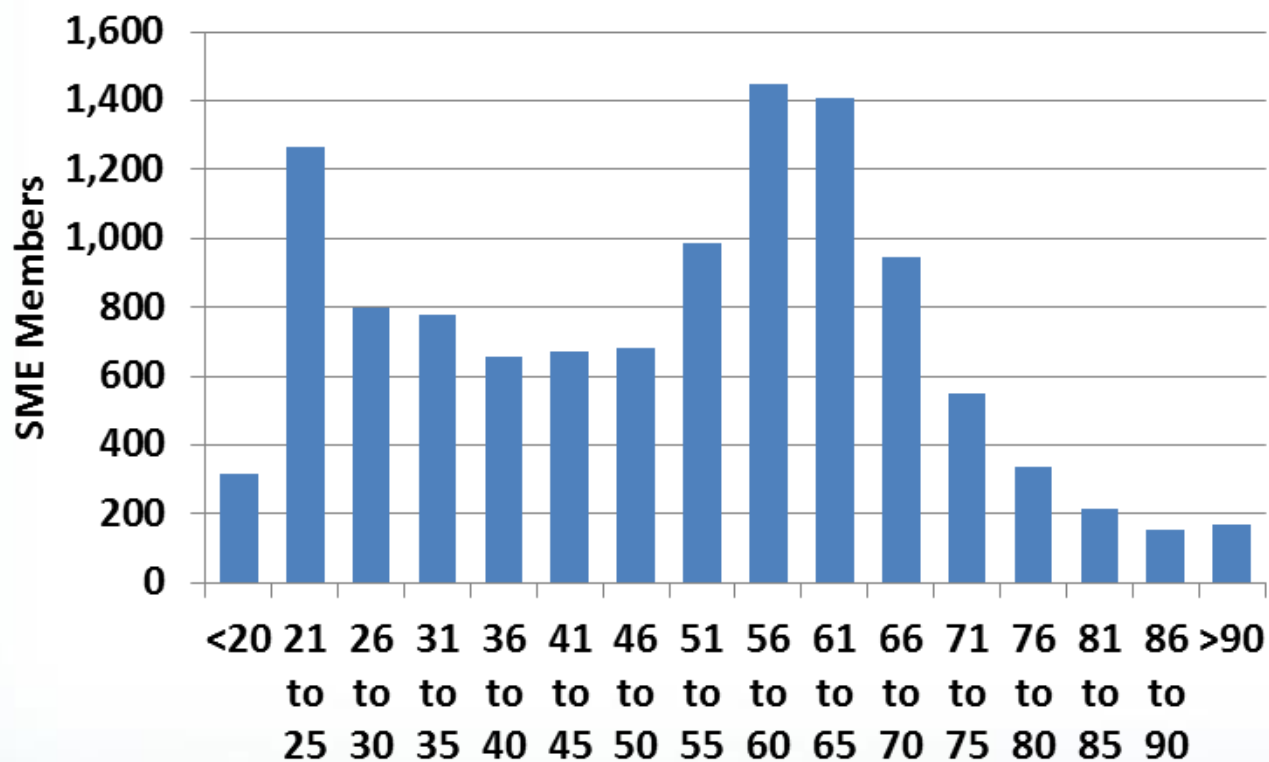
- **H** ealth of the Society
- **E** ducational Sustainability
- **L** ocal Section Engagement
- **P** ublic Perception
- **S** afety and Health

Eleven Consecutive Years of Operating Surplus Through 2015



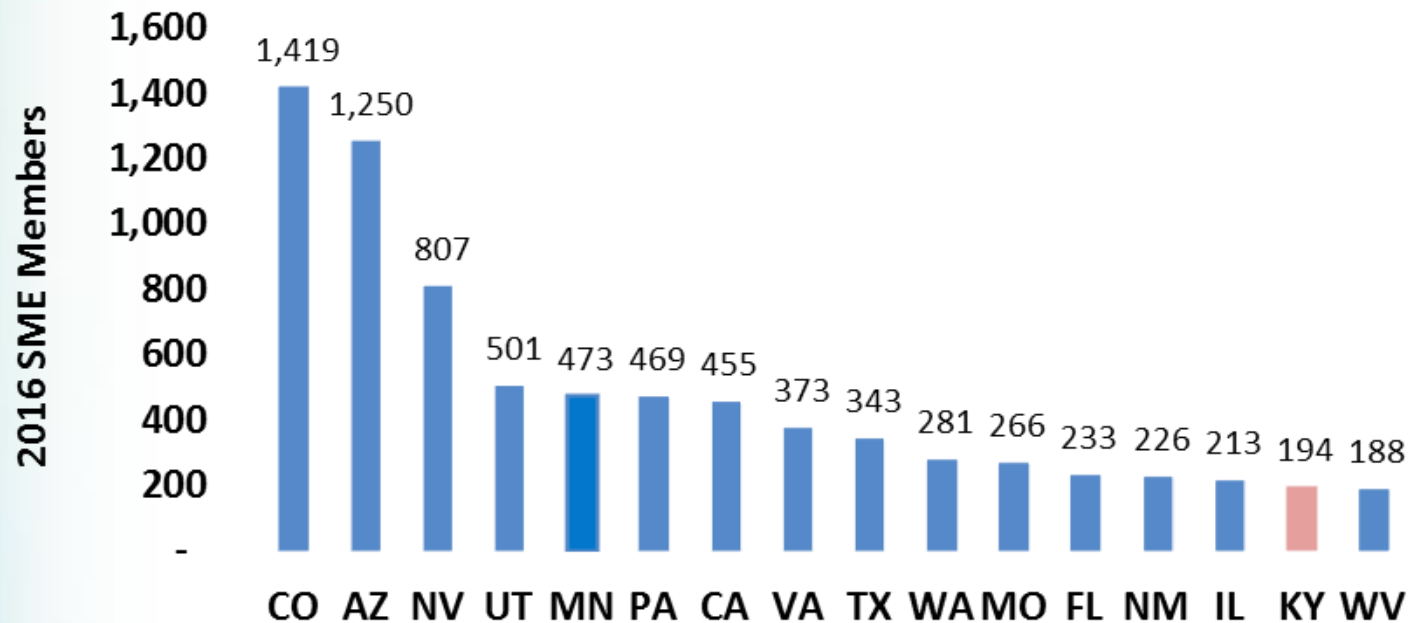
Health of the Society - Membership

Age Distribution of SME in 2016



Health of the Society - Membership

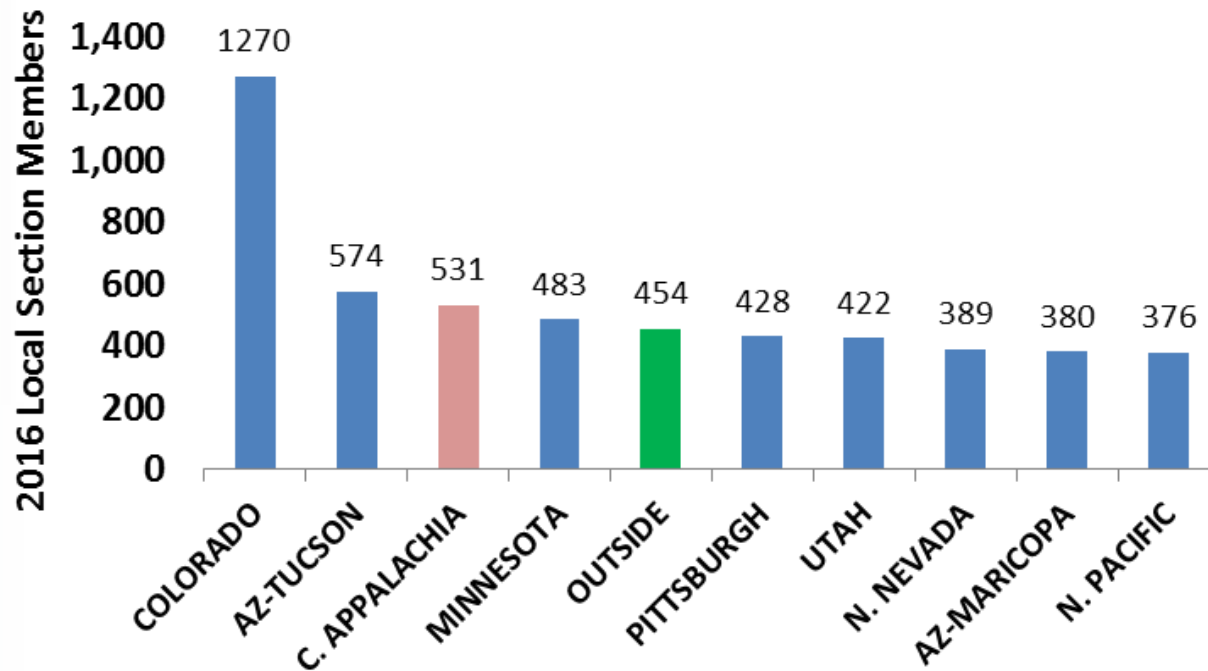
16 States with the Larger Memberships





Health of the Society - Membership

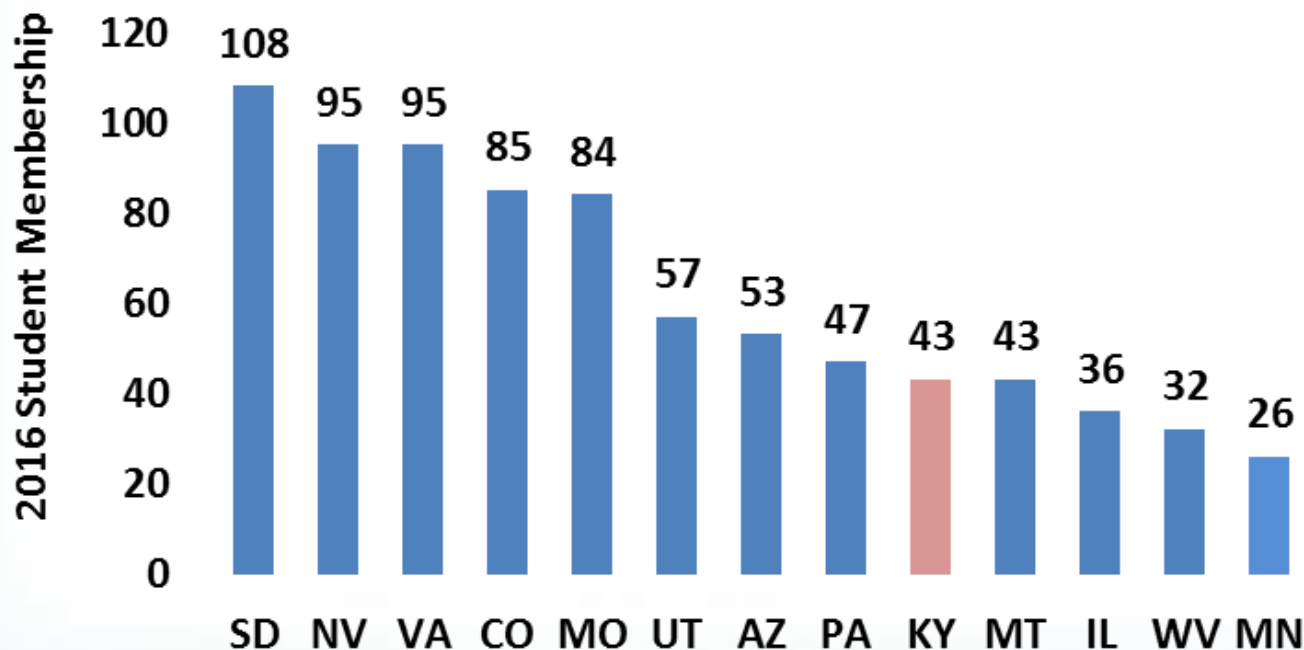
SME's 10 Larger Local Sections



Health of the Society - Membership

80% of Student Membership is in 13 States

Student Membership by State (80%)

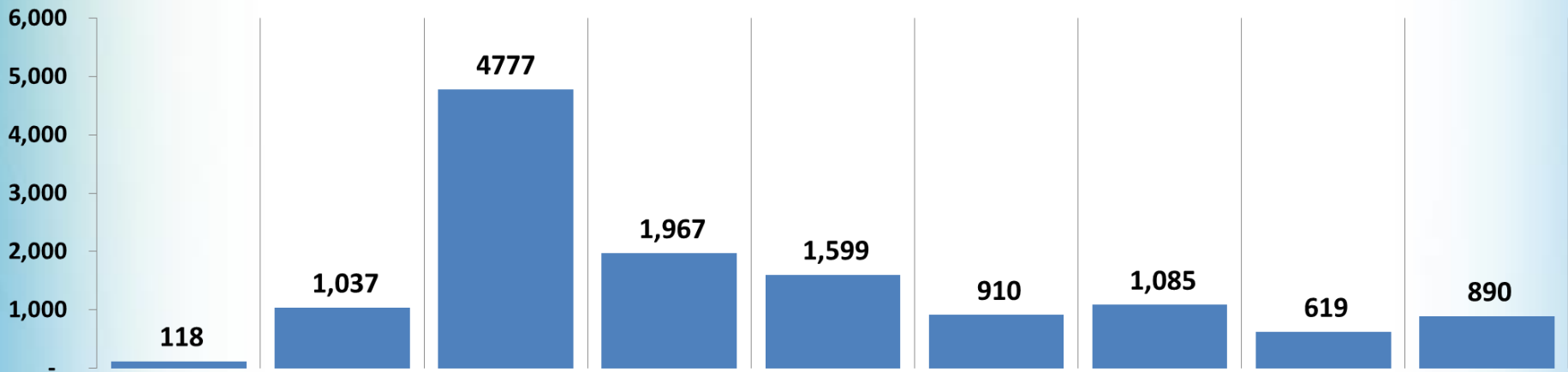




Health of the Society - Membership

SME Membership by Division, Dec 31, 2016

Divisions by Operational Functions				Divisions by Commodity		Divisions by Activity		Unaffiliated
Health & Safety	Environmental	Mining & Exploration	Metallurgical & Mineral Processing	Coal & Energy	Industrial Minerals & Aggregates	Underground Construction	Women's Auxilliary of AIME	Based on Technical Interest
2015	1997	1949	1948	1930	1935	2007	2008	-

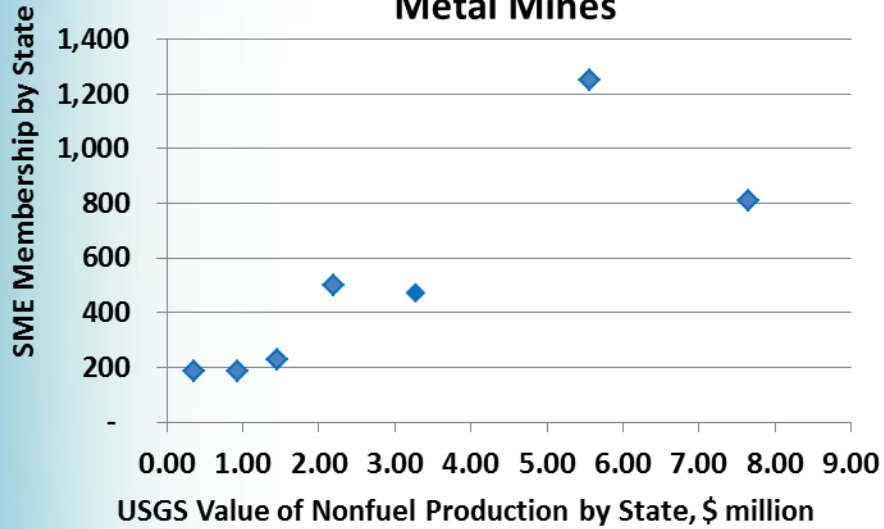


Trends with Others	Trends with Others	Copper, Gold, Silver, Iron Ore, PGM, Zinc, Lead, Nickel	Coal	Stone, Sand, Gravel, Cement, Soda Ash, Potash,	Municipal & Highway Tunnel Projects	Scholarships, Literacy, Disaster Relief	Education, Bulk Materials, Undeclared
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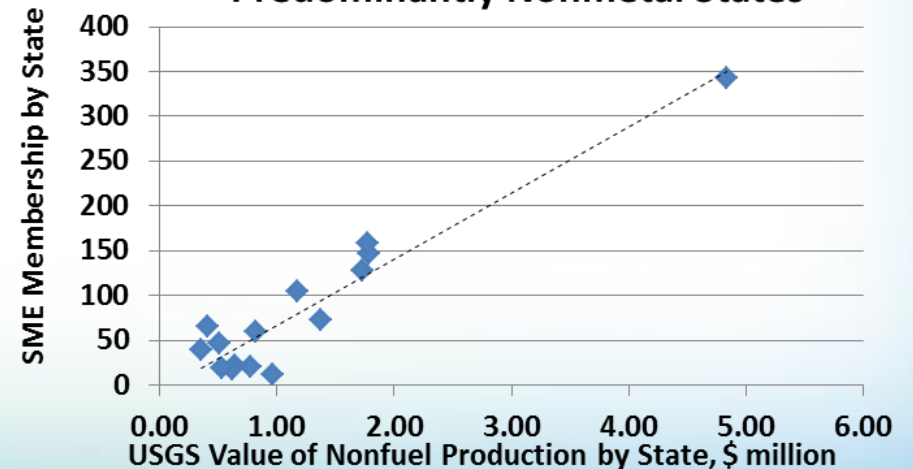


Health of the Society - Membership

SME Membership and Production Value for Metal Mines



Membership and Top 15 Production Value Predominantly Nonmetal States

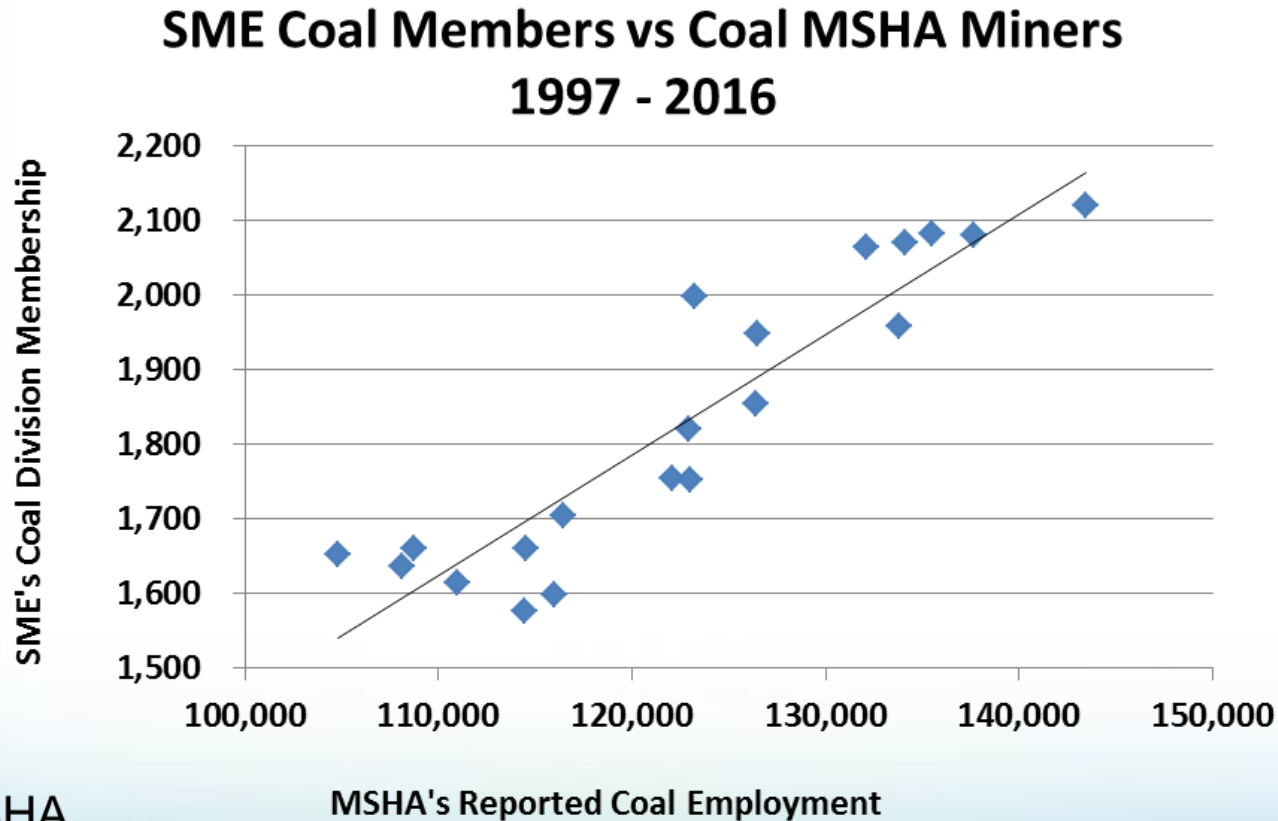


Source: 2017 USGS Mineral Commodity Summaries



Health of the Society - Membership

SME Coal Division Compares Well with Coal Employment as Reported by MSHA



Source: MSHA



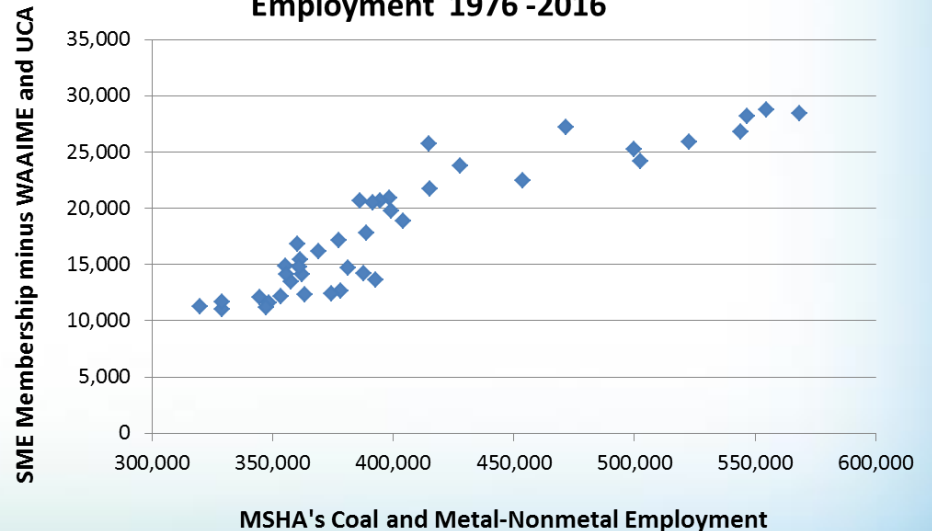
Health of the Society - Membership

Total SME Membership Lags Industry Employment, ~ 3 year Lag

SME Membership Lags Employment Changes

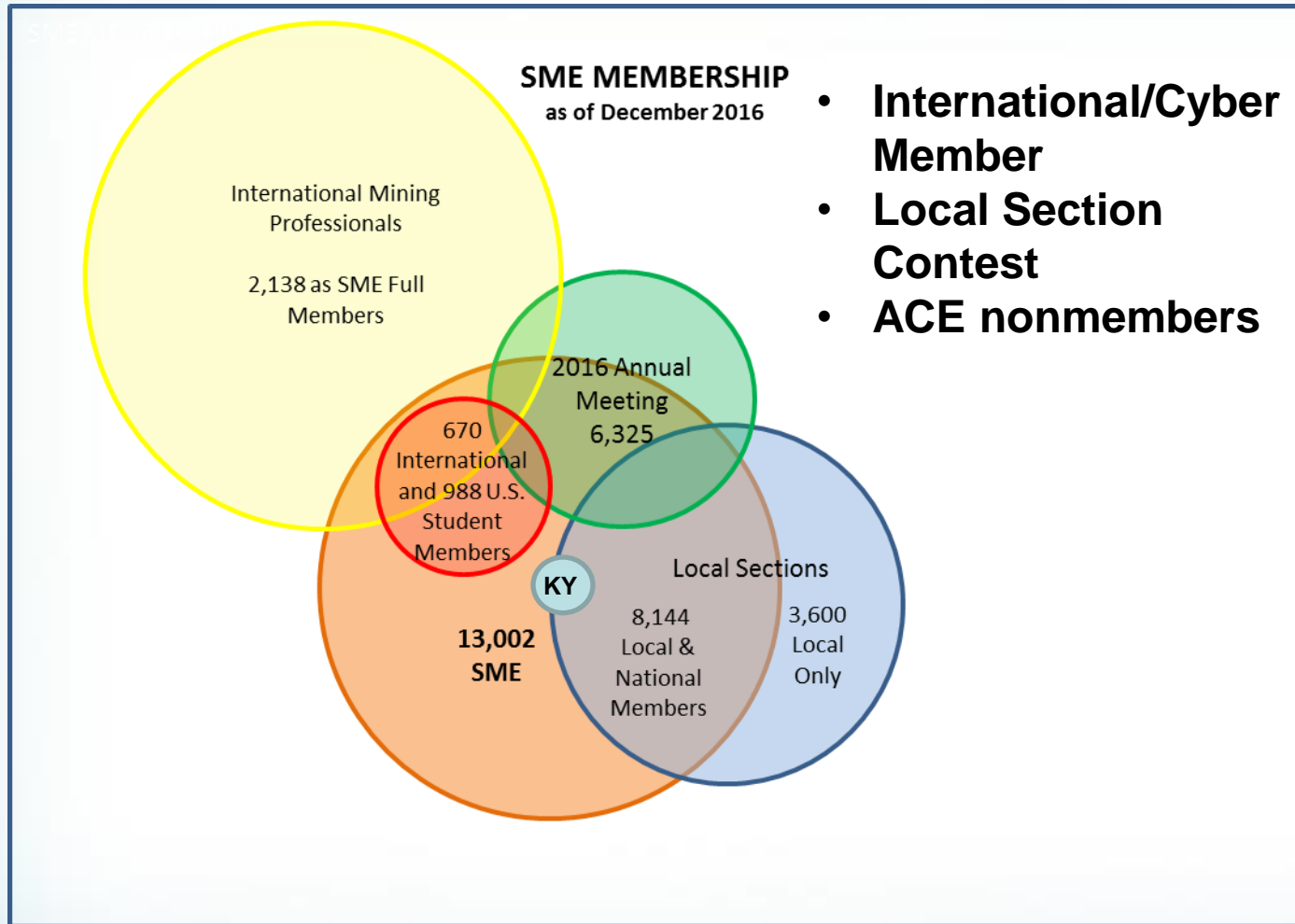


SME Membership Increases with Mining Employment 1976-2016



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Health of the Society - Membership

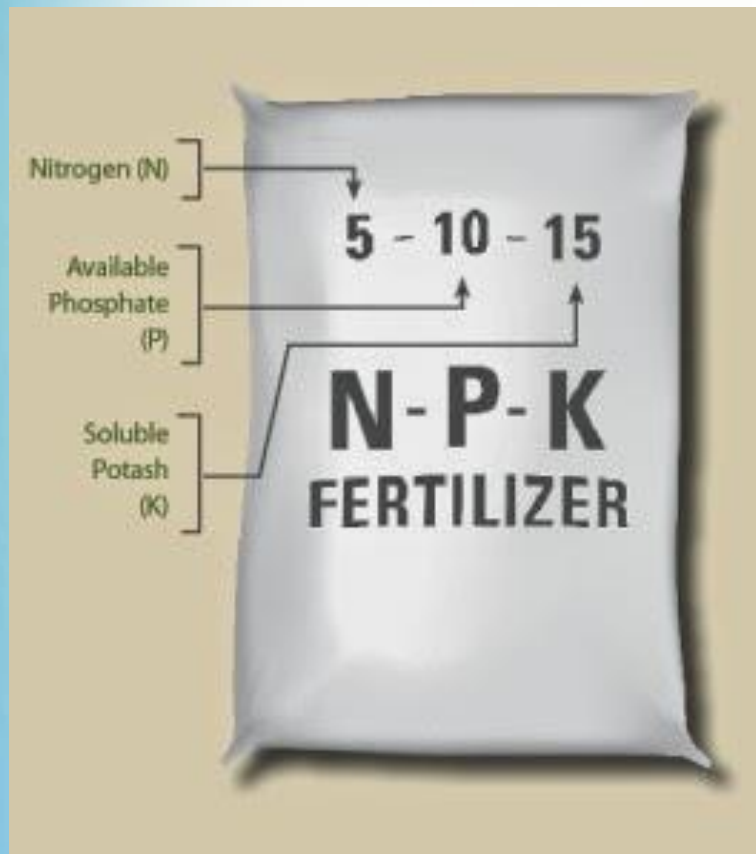




Sunrise Over the Product Domes at East

SME

What is Potash?



Miracle-Gro® Water Soluble
Bloom Booster® Flower Food
10-52-10

F 1198

GUARANTEED ANALYSIS

Total Nitrogen (N)	10%	Derived from Ammonium Phosphate, Potassium Phosphate, Boric Acid, Copper Sulfate, Iron EDTA, and Manganese EDTA.
10% Ammoniacal Nitrogen		
Available Phosphate (P ₂ O ₅)	52%	Information regarding the contents and levels of metals in this product is available on the internet at: http://www.regulatory-info-sc.com
Soluble Potash (K ₂ O)	10%	
Boron (B)	0.02%	KEEP OUT OF REACH OF CHILDREN Scotts Miracle-Gro Products, Inc. 14111 Scottslawn Road Marysville, OH 43041
Copper (Cu)	0.07%	
0.07% Water Soluble Copper (Cu)		
Iron (Fe)	0.15%	
0.15% Chelated Iron (Fe)		
Manganese (Mn)	0.05%	
0.05% Chelated Manganese (Mn)		

What is Potash?

Major Types of Potash Fertilizer and K_2O Content

MOP	Muriate of Potash	60%
SOP	Sulfate of Potash	50%
SOP-Mg	Sulfate of Potash Magnesia	22%
NOP	Nitrate of Potash	43%



What is Potash?

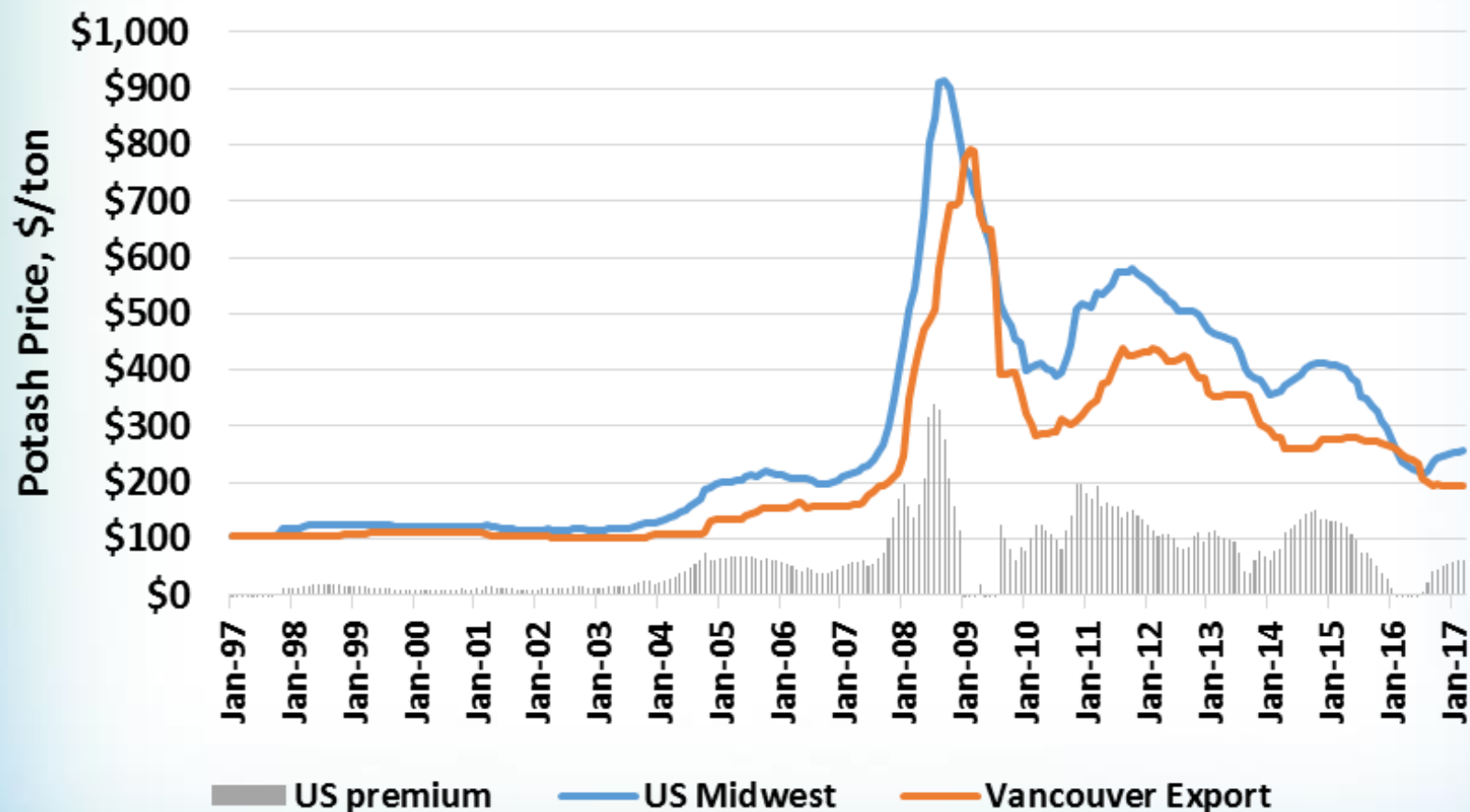
2016 Potash Consumption Top 3 Regions

Asia	30 to 35 million tpa of product
S. America	10 to 15 million tpa of product
N. America	9 to 10 million tpa of product



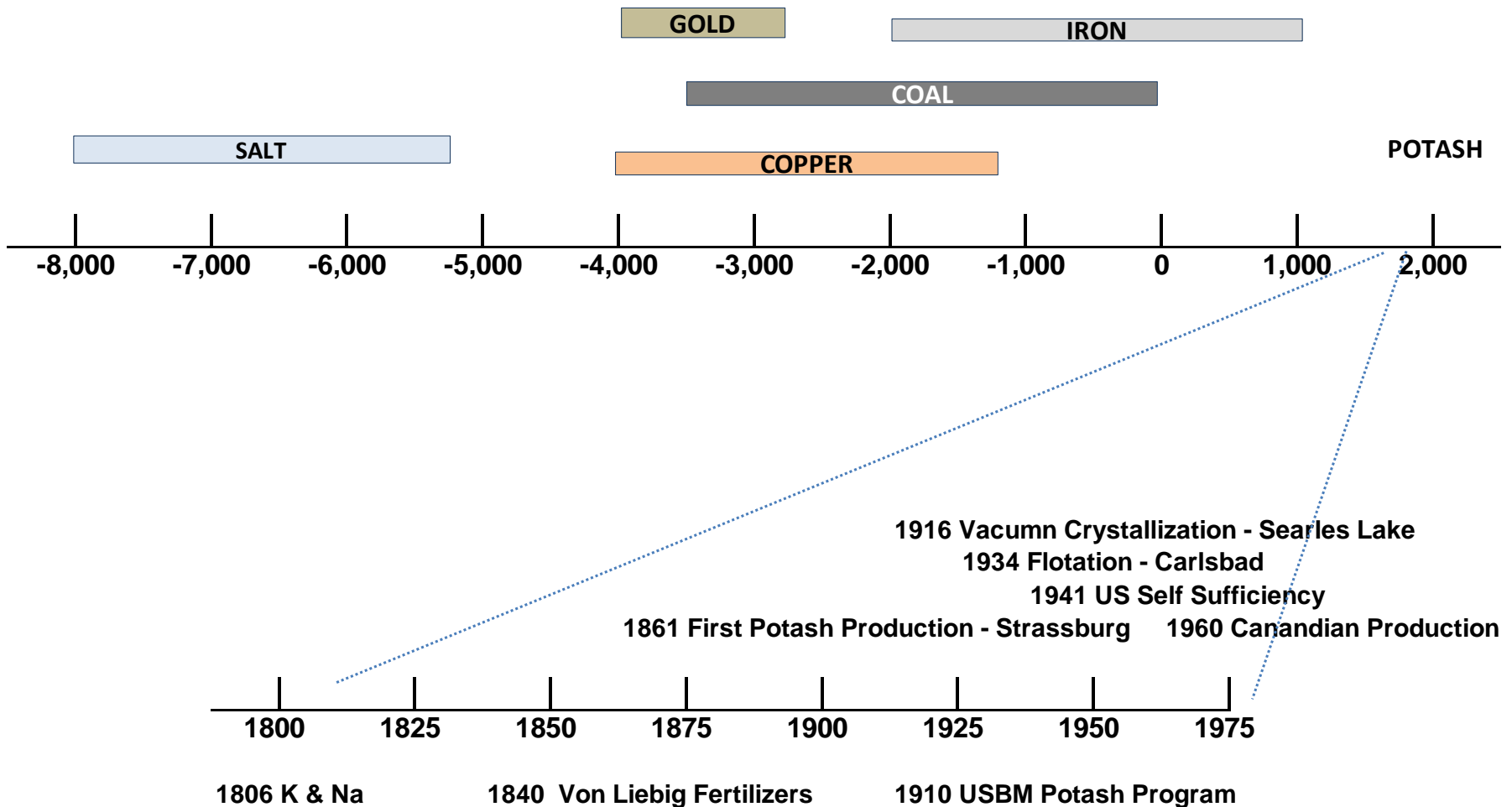
What is Potash?

Historic Potash Prices



Sources: Green Markets, World Bank

TIMELINE FOR MINERAL PROCESSING AND REFINING



Potash Mineralization and Ores

Mineral	Composition	Percent K ₂ O	Specific Gravity
Primary Potash Minerals			
Sylvite	KCl	63.2%	2.00
Carnallite	KCl·MgCl ₂ ·6H ₂ O	16.9%	1.60
Langbeinite	K ₂ SO ₄ ·2MgSO ₄	22.7%	2.83
Polyhalite	K ₂ SO ₄ ·2CaSO ₄ ·MgSO ₄ ·2H ₂ O	15.6%	2.77
Accessory Potash Minerals			
Kainite	KCl·MgSO ₄ ·3H ₂ O	19.3%	2.10
Leonite	K ₂ SO ₄ ·MgSO ₄ ·4H ₂ O	25.7%	2.20
Schoenite	K ₂ SO ₄ ·MgSO ₄ ·6H ₂ O	23.4%	2.03

Ore	Composition	Percent K ₂ O
Primary Potash Ores		
Sylvinitite	Halite and sylvite	Typically < 25
Carnallitite	Halite and carnallite	Typically < 15
Hartsalz	Halite, sylvite, anhydrite, and kieserite	Typically < 15
Brine	Potassium enriched brine	> 0.5

Processing Options

- Sylvite ores – flotation, hot leach crystallization, dense media pretreat
- Carnalite ores – reverse flotation, hot leach crystallization, selective decomposition
- Hartsalz ores – electrostatic separation, hot leach crystallization, flotation, selective decomposition
- Langbeinite ores – dense media, gravity, water leach
- Brine sources – evaporation, salt exchange

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Potash Processing

Special Considerations

- Water soluble minerals and products
- High specific gravity and viscosity of brines
- High ionic strength of the brines
- Pseudo-phase equilibrium
- Unintended salting of brines
- Hygroscopic nature of sylvite

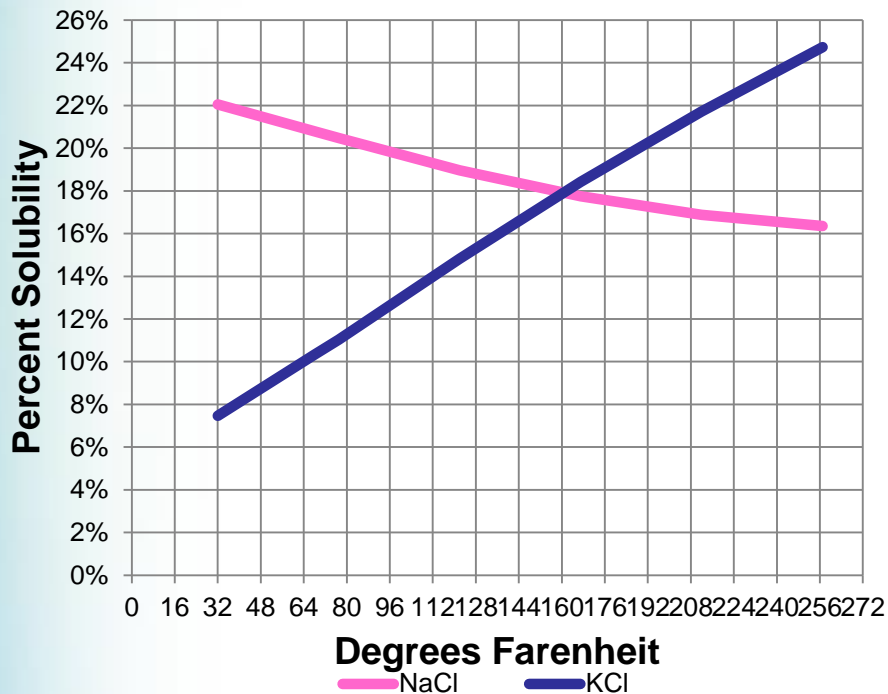


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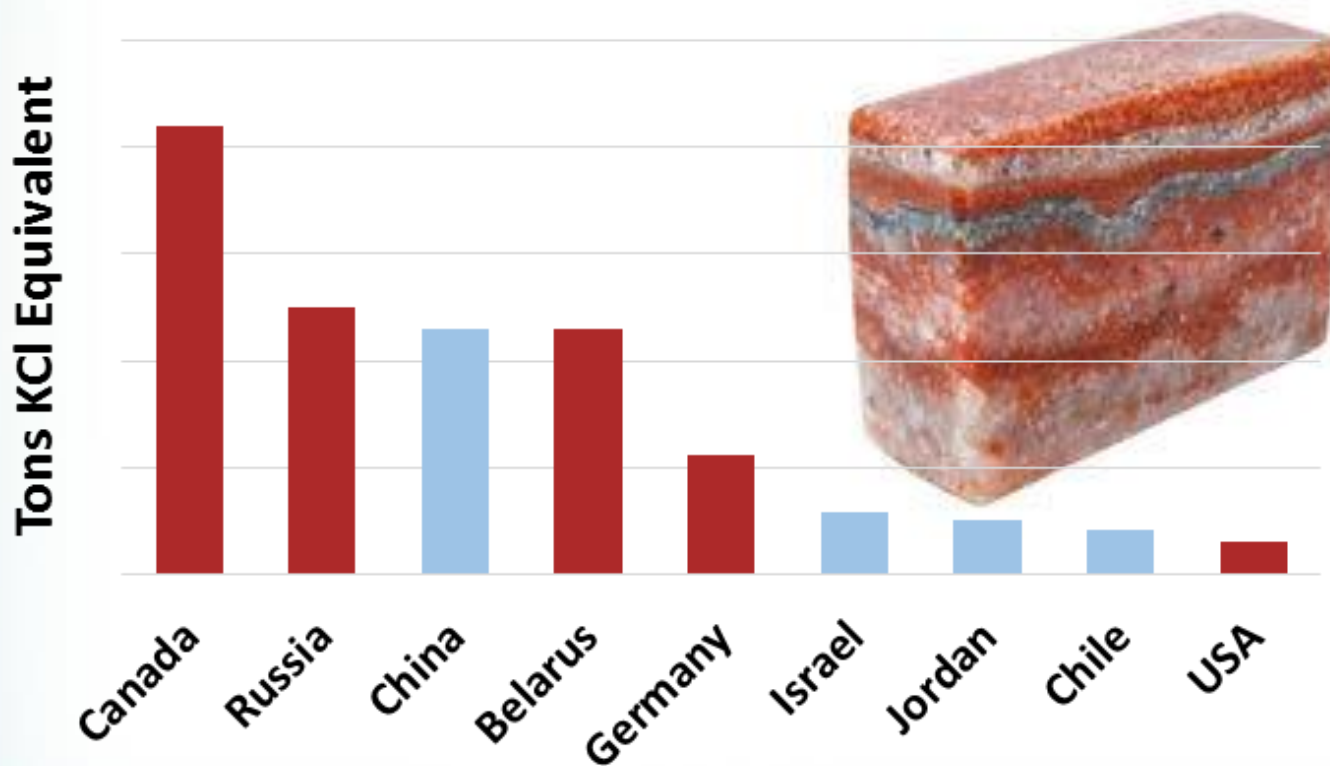
Potash Processing



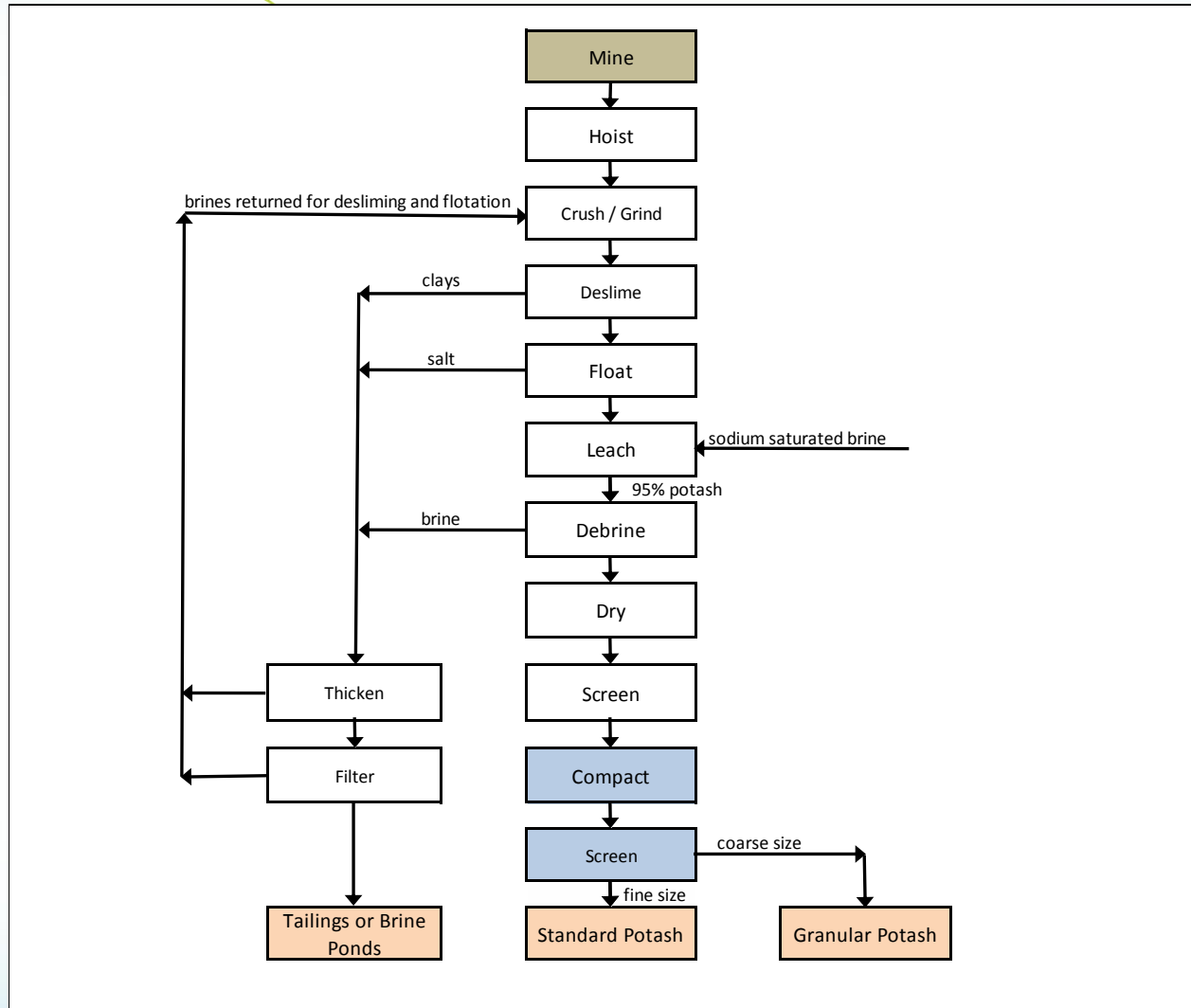
Solubilities of Double Saturated Solution



2015 Relative Potash Production



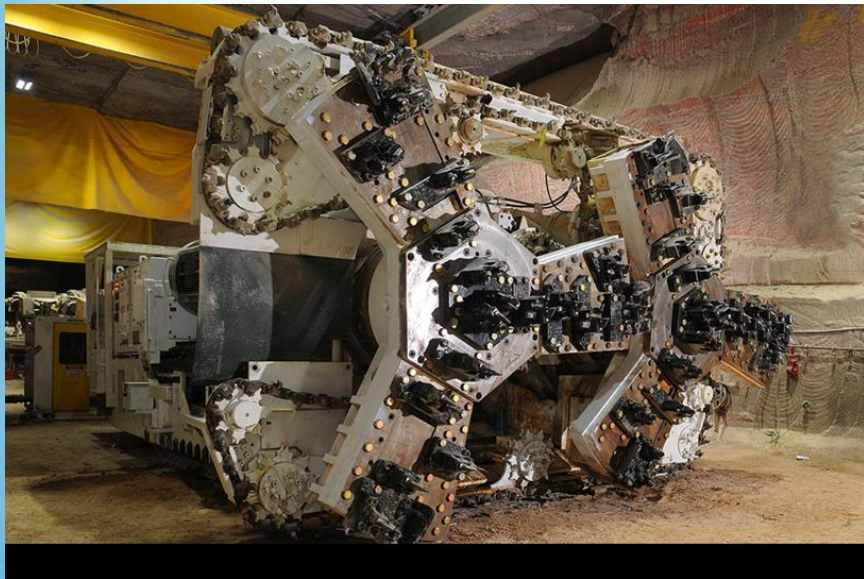
Blue bars represent sea, lake or solar based production



Potash Mining

Underground mining

- Depths 1000 -1300 m (3281 - 4270')
- Plastic conditions



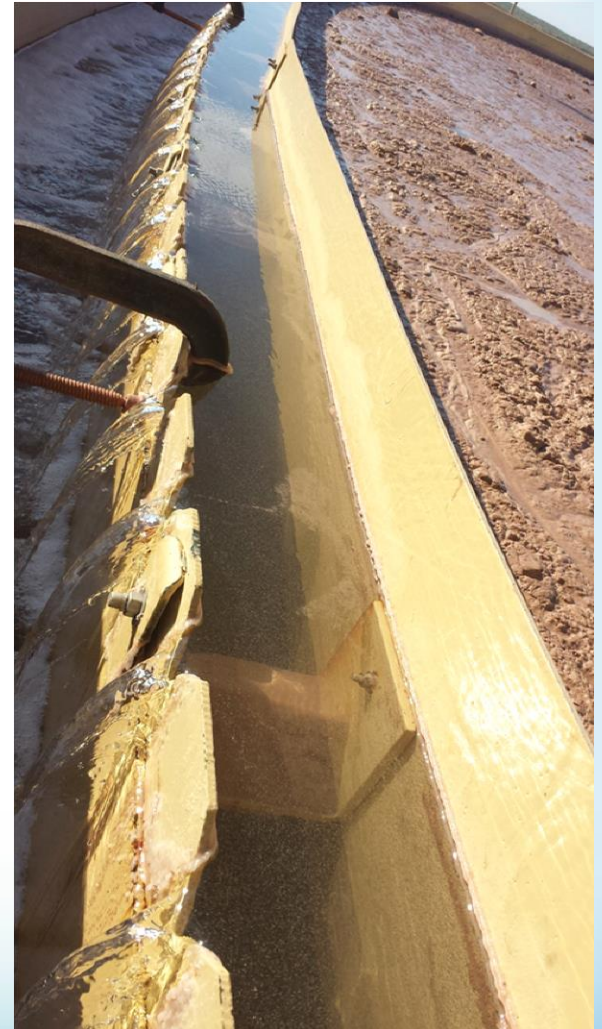
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Potash Mining



Sizing & Desliming

- Sizing is critical
- Insoluble materials 0.5% to 12%
- Methods include
 - Multi-stage attrition scrubbing, screening and hydraulic classification
 - Flocculation & reverse flotation,
 - Complexing agents
- Brine clarity is extremely important





Reagent	g/tonne
Amine	50 to 150
Oil	30 to 40
Frother	20 to 30
Depressant	200 to 300

- Fatty amine collector, extender oil, frother
- Concentrate leach to make final grade
- Denver cells very common

Debrining and Drying

- Recovery of brine is critical to optimizing recovery
- Low moistures required to ensure product quality, especially with magnesium brines
- Minimization of breakage must be managed for friable materials
- Equipment choice, typically centrifuges 2 - 4% moisture
- Coat with anti-cake or de-dust post drying

Tails Management

- Washing tails
- Recovery of brine is critical to optimizing recovery
- Centrifuges, belt filters, pan filters

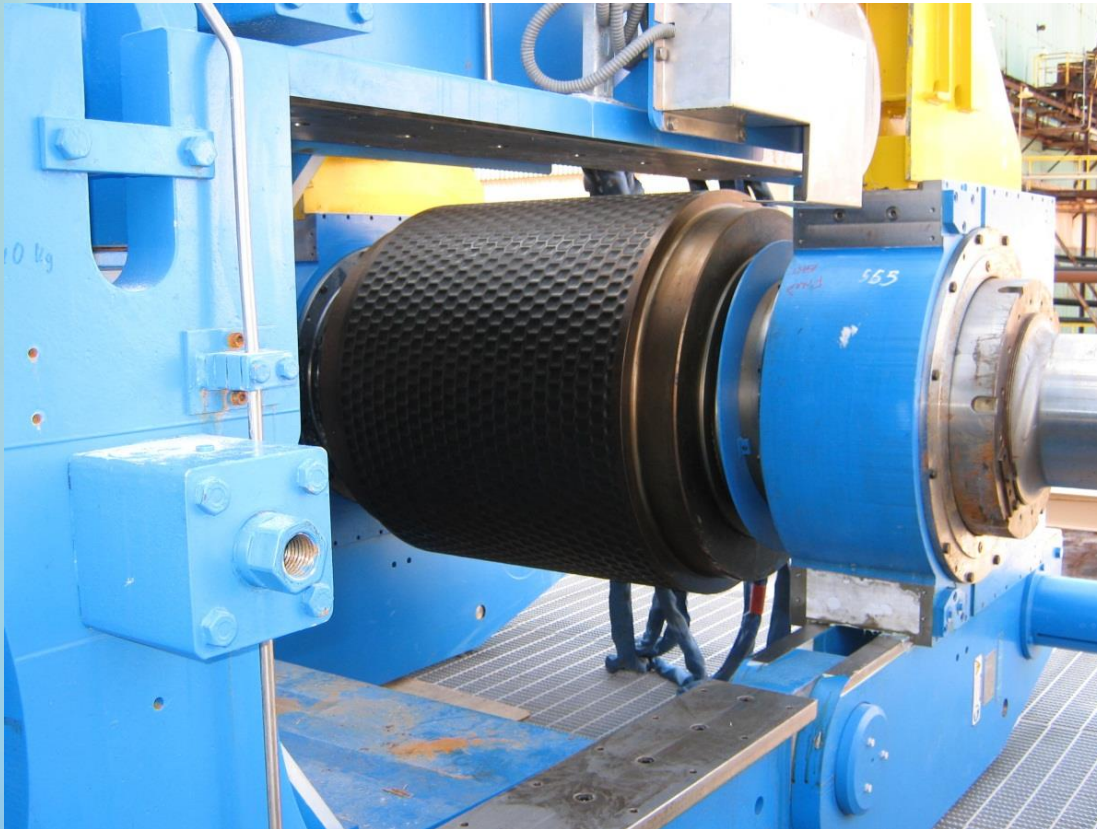


Potash Processing Tails Management

- Stacked
- Backfill
- Marine
- Riverine



Agglomeration



SME

Potash Processing



PRODUCT	SIZE d_{50} (mm)
Premium – Pellet	2.70
Granular	2.70
Standard	1.05
Fine Standard	0.05

Langbeinite

- Coarse fine split
- Dense media for coarse
- Reflux classifier for fines
- Pelletize fine materials



Premium



Granular

Processing Options

- Carnalite ores – reverse flotation, hot leach crystallization, selective decomposition



- Hartsalz ores – electrostatic separation, hot leach crystallization, flotation, selective decomposition

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Potash Processing





Educational Sustainability

Fundraising Challenge for SME Foundation

