

# Potash Mining and Processing 101



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# What is Potash?

In Saskatchewan,

**Potash** = **Sylvite** + **Halite** + **Insolubles** ± **Carnallite**

**Sylvite** (or potassium salt, **KCl**), is the desired ore mineral.

**Halite** (or sodium salt, **NaCl**), is ordinary table salt.

**Insolubles** include detritus and other fine-grained anhydrite-dolomite-quartz minerals and are commonly referred to as 'Clays'.

**Carnallite** (**KCl·MgCl<sub>2</sub>·6H<sub>2</sub>O**), is a magnesium-bearing mineral salt and is considered an ore contaminant.



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# Potash Uses

Use Category	Typical Applications
<b>Agriculture (Primary Use)</b>	Crop fertilizers for grains, oilseeds, fruits, vegetables; improves yield, quality, and stress resistance
<b>Specialty Agriculture</b>	Chloride-sensitive crops; greenhouse and horticultural fertilizers
<b>Industrial Uses</b>	Glass and ceramics; soaps and detergents; drilling fluids; metal processing
<b>Chemical Production</b>	Potassium hydroxide, carbonate, nitrate, sulfate for industrial and chemical manufacturing
<b>Food &amp; Nutrition</b>	Food processing; preservatives; salt substitutes; animal feed
<b>Pharmaceuticals &amp; Medical</b>	IV fluids; electrolyte replacement; medical formulations
<b>Other Uses</b>	De-icing; water treatment; pyrotechnics and specialty chemicals



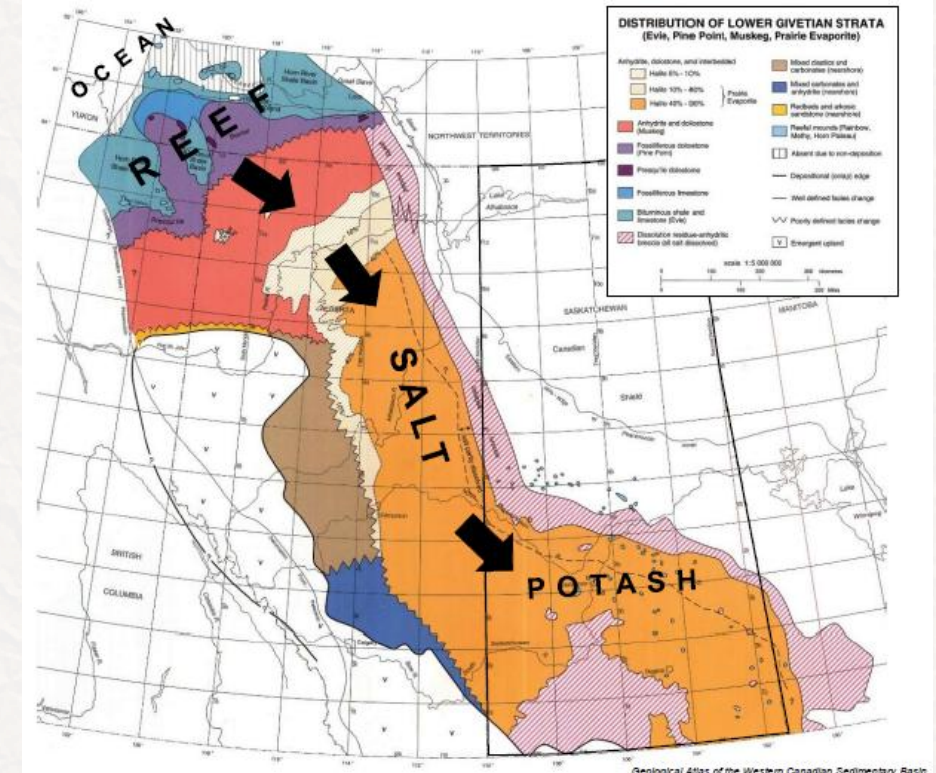
*Potash: Finished product*



# Regional Geology

## Devonian Prairie Evaporite Formation

- Deposited ~385–360 million years ago during the Devonian period
- Formed in a large, restricted inland sea undergoing repeated evaporation cycles
- Evaporation concentrated dissolved salts, precipitating sequential evaporite minerals
- Potash-bearing members are laterally continuous across much of southern Saskatchewan
- Typical mining depth: 800–1,100 m below surface



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# Regional Geology

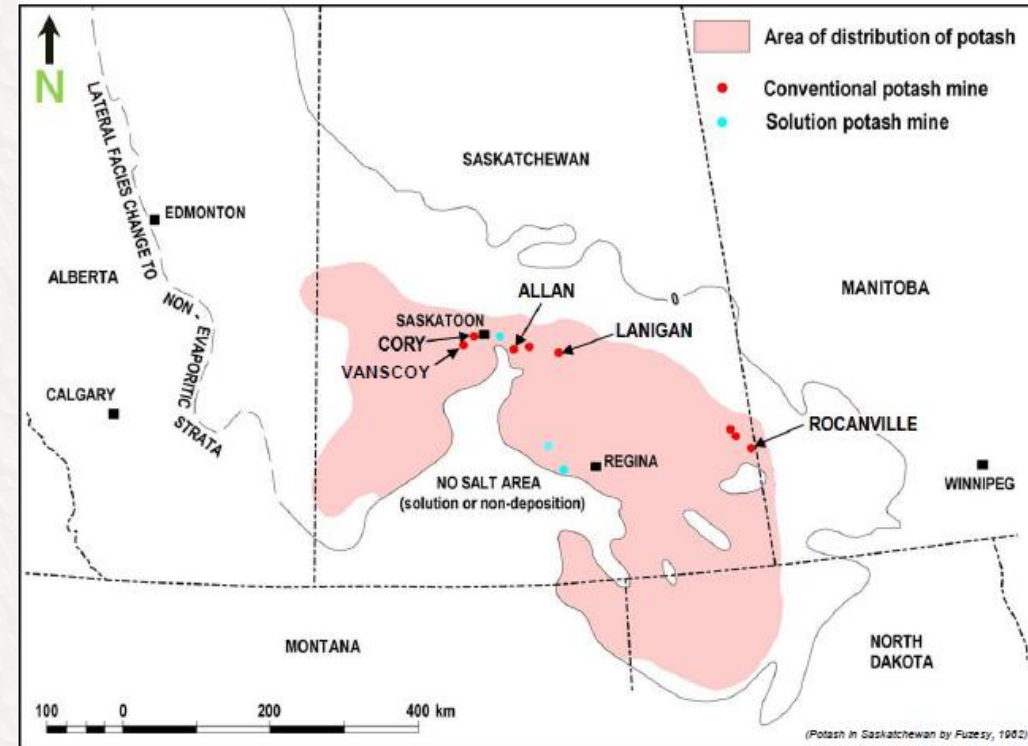
## Prairie Evaporite Formation

- Predominantly Salt
- Laterally continuous and flat-lying
- Up to +200m thick
- Potash beds within upper 50m
- Deposit deepens southwards
- 3 Economic Potash Members:

Patience Lake Member

Belle Plaine Member

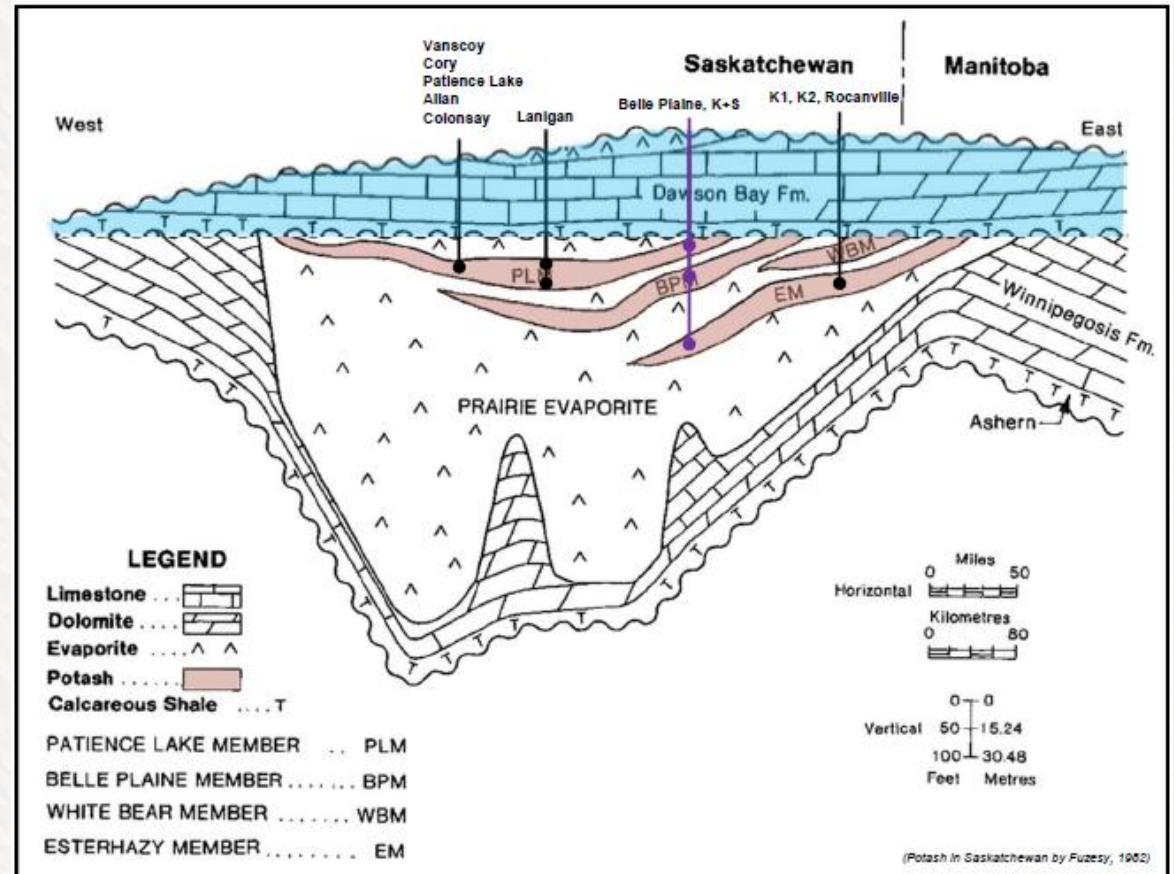
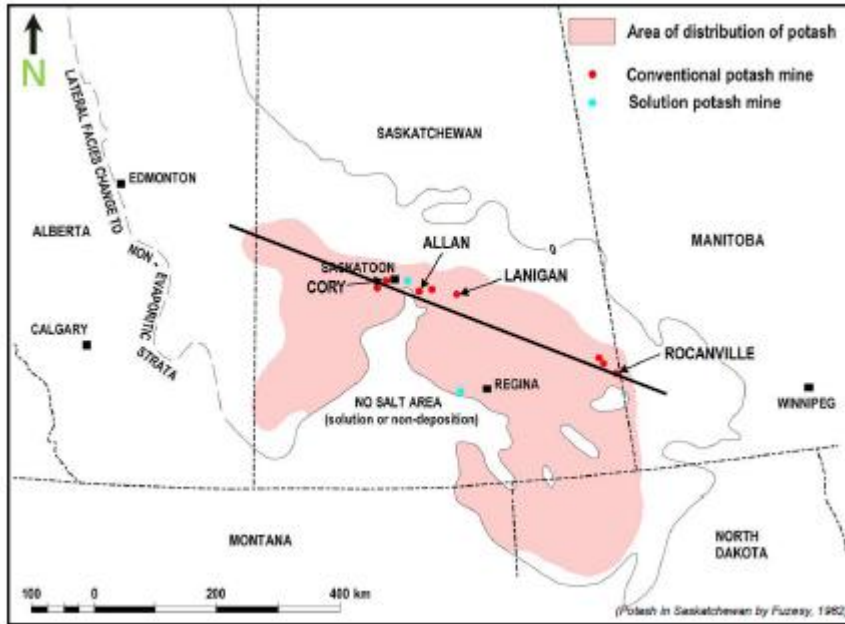
Esterhazy Member



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# Regional Geology

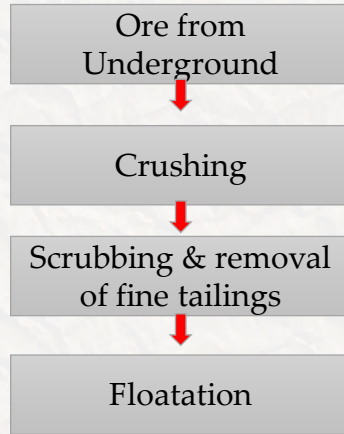
## Prairie Evaporite Formation (Cross Section)



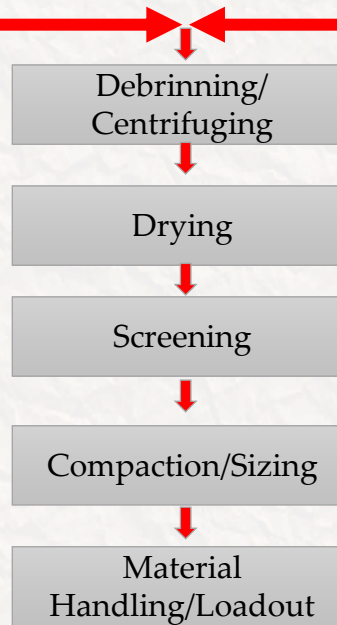
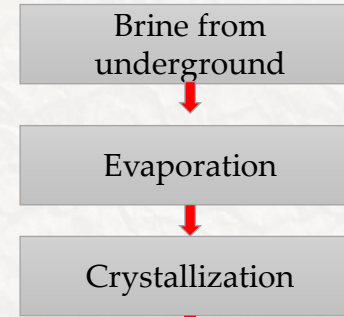
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# Mining Methods Used in Saskatchewan

## Conventional Mining



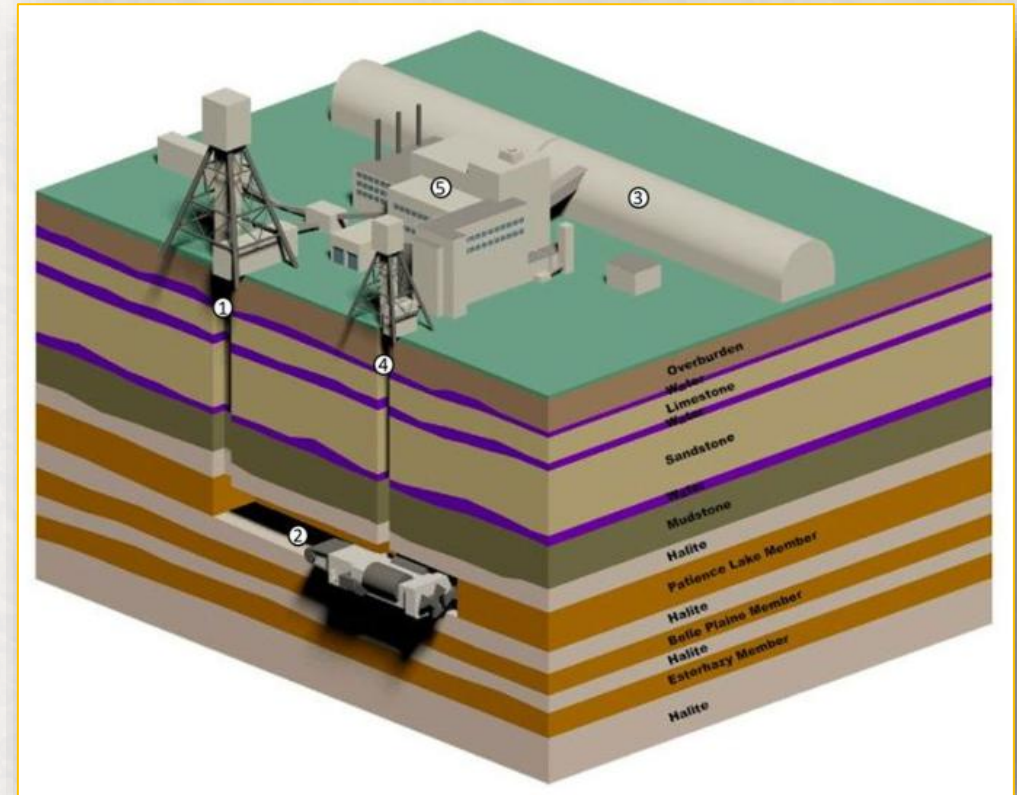
## Solution Mining



# Mining Methods Used in Saskatchewan

## Conventional Underground Mining

- Used where potash beds have sufficient thickness, grade, and ground stability
- Involves sinking vertical shafts (production, service, and ventilation) to the ore zone
- Mining method is typically room-and-pillar, where:
  - Continuous miners cut the ore horizontally
  - Pillars of unmined rock are left to support the roof
- Broken ore is conveyed underground and hoisted to surface via skips



1)Service Shaft 2)Mining Machines 3)Ore Storage  
4)Production Shaft 5)Process Plant

[Source: Potash Mining - GensourceGensource](#)



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# Mining Methods Used in Saskatchewan

## Conventional Underground Mining

### Advantages:

- Direct access to ore with high recovery in suitable geology
- Well-established technology in Saskatchewan

### Challenges:

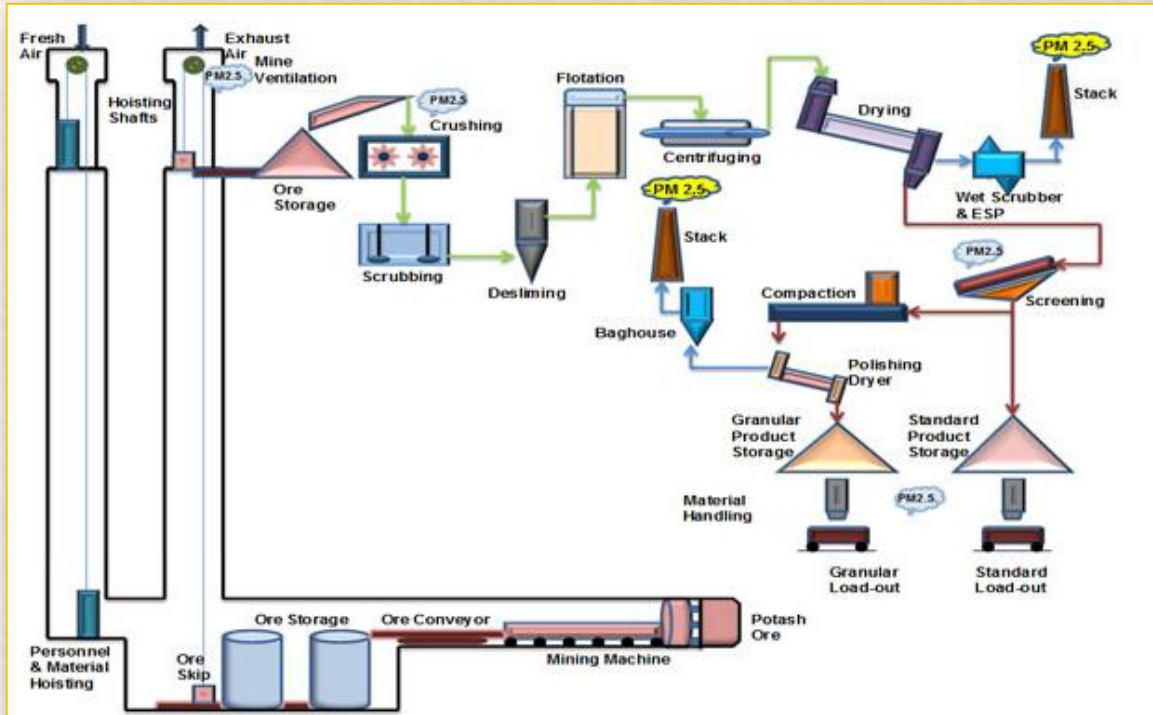
- High capital cost for shafts and underground infrastructure
- Ground control issues due to salt creep at depth
- Risk of water inflow from overlying aquifers



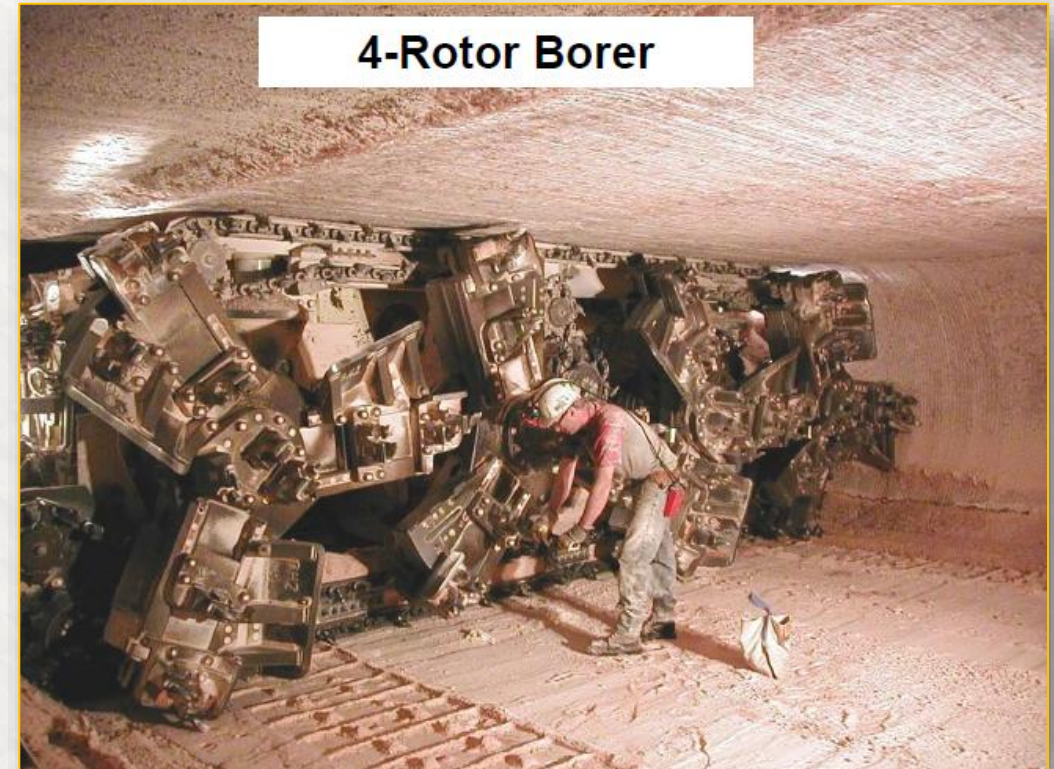
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# Mining Methods Used in Saskatchewan

Conventional Underground Mining/Milling Process Flow sheet



Source: Code of practice for managing particulate matter emissions in the potash sector: chapter 2 - Canada.ca



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# Shaft Access in Conventional Underground Potash Mining

Conventional underground potash mines in Saskatchewan rely on multiple dedicated shafts, each designed for a specific function to ensure safe, efficient, and continuous operation.

## Production Shaft

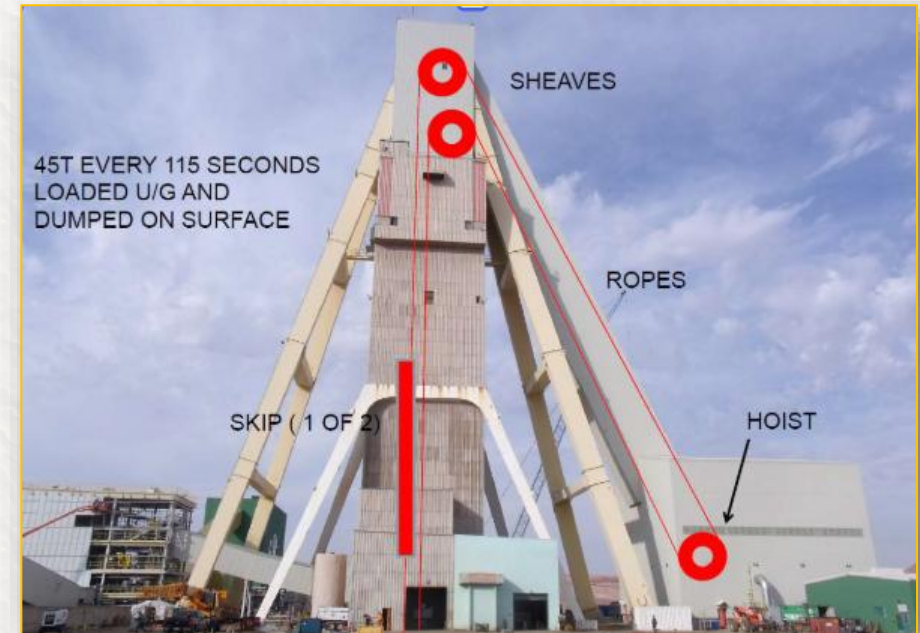
- Primary shaft used to hoist mined ore from underground to the surface

Equipped with:

- Large skips designed for high-tonnage bulk material handling
- Hoisting systems sized for continuous, high-throughput operations

## Critical design considerations:

- Shaft diameter and hoist capacity matched to planned production rate
- Redundancy and reliability to avoid production downtime



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# Shaft Access in Conventional Underground Potash Mining

Conventional underground potash mines in Saskatchewan rely on multiple dedicated shafts, each designed for a specific function to ensure safe, efficient, and continuous operation.

## Service (Personnel and Material) Shaft

- Used for:
  - Transporting workers, equipment, and consumables
  - Emergency egress and access for maintenance activities
- Typically fitted with cages rather than skips
- Provides operational flexibility and redundancy
- Often serves as the primary access route during shaft sinking, mine development, and maintenance outages



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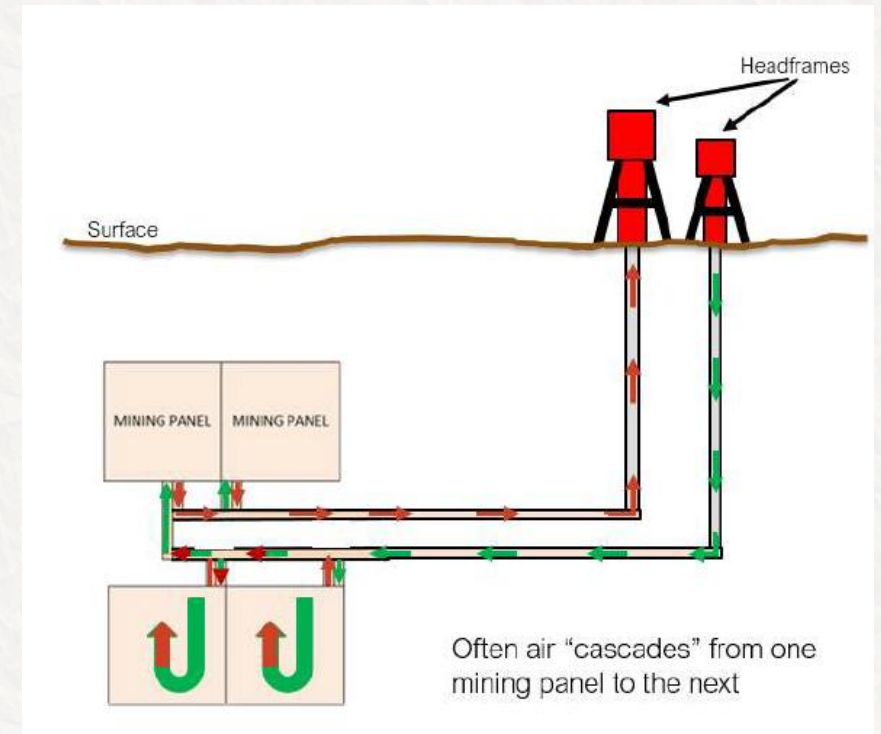
# Shaft Access in Conventional Underground Potash Mining

Conventional underground potash mines in Saskatchewan rely on multiple dedicated shafts, each designed for a specific function to ensure safe, efficient, and continuous operation.

## Ventilation Shaft(s)

Dedicated shafts to manage mine ventilation requirements

- Enable:
  - Fresh air delivery to underground workings
  - Exhaust of heat, dust, diesel emissions, and gases
- Particularly important in deep Saskatchewan potash mines due to:
  - Elevated ambient rock temperatures
  - Large mine footprints and long airways
- Ventilation design strongly influences:
  - Worker safety
  - Energy consumption
  - Mine layout and expansion potential



*Airflow from ventilation shaft to underground mining panels*



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# Process Flow – Conventional Mining

- Underground Mining → Crushing → Hoisting
  - Surface Crushing & Sizing
  - Flotation Separation and Tailings
  - Drying → Compaction/Granulation → Storage & Shipping



# Process Flow – Conventional Mining

## Underground Mining → Crushing → Hoisting

- Potash ore is extracted underground using continuous mining machines in a room-and-pillar layout.
- Run-of-mine (ROM) ore is typically coarsely crushed underground to:
  - Control fragment size
  - Improve conveyor and hoisting efficiency
  - Reduce wear on surface equipment
- Crushed ore is transported via underground conveyors to shaft bottoms
- Ore is hoisted to surface using production shafts and skips, designed for high-tonnage continuous operation
- Hoisting capacity often constrains overall mine throughput

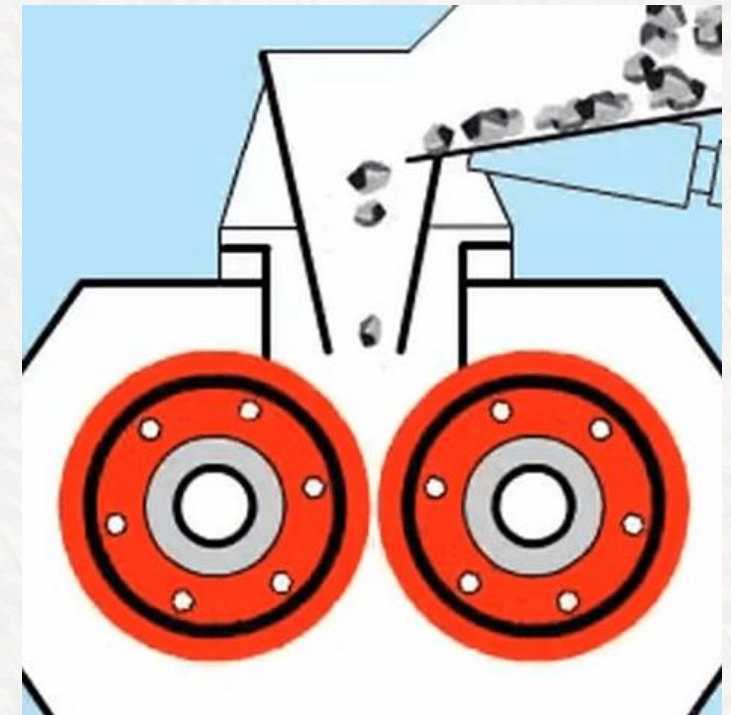


# Process Flow – Conventional Mining

## Surface Crushing & Sizing

- Hoisted ore undergoes secondary and tertiary crushing at the surface/Milling plant
- Crushing targets a particle size suitable for downstream separation (typically <1–2 mm for flotation feed).
- Screening separates:
  - Oversize material (recycled back to crushers)
  - Fines that may bypass crushing
- Size control is critical for:
  - Flotation performance
  - Product quality consistency
  - Minimizing slimes generation

*Roll Crusher animation*



[Potash Flotation Process - 911Metallurgist](#)

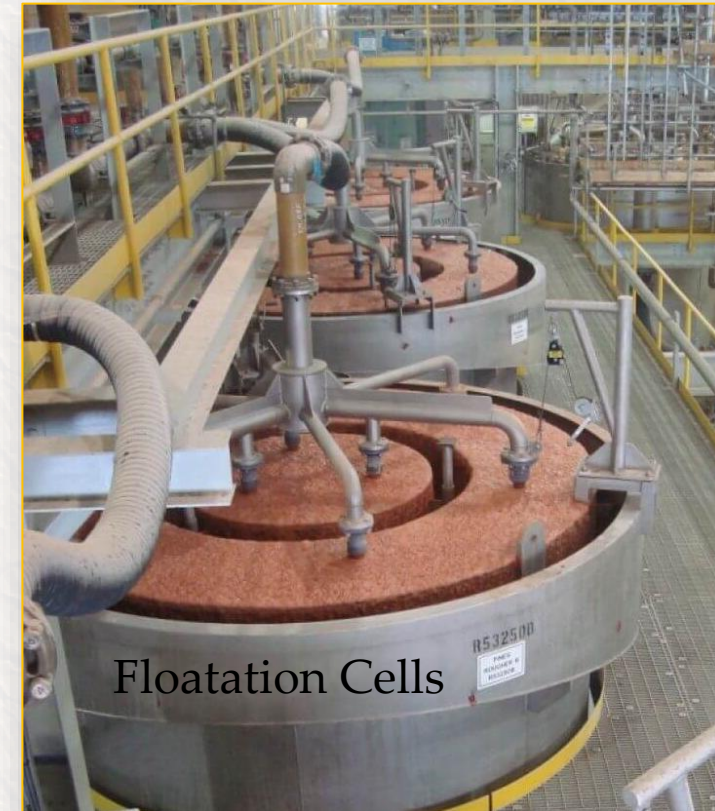


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# Process Flow – Conventional Mining

## Flotation Separation

- The crushed ore slurry is sent to flotation circuits to separate KCl from NaCl.
- Separation is based on surface chemistry:
  - Reagents selectively make KCl hydrophobic
  - KCl attaches to air bubbles and floats
  - NaCl and insolubles sink and report to tailings
- Multiple flotation stages may be used:
  - Rougher, Cleaner, Scavenger
- Outputs:
  - Potassium-rich concentrate
  - Salt tailings (primarily NaCl)
- Flotation efficiency strongly affects:
  - Recovery rates, Tailings volumes, Operating costs



[Potash Flotation Process - 911Metallurgist](#)



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# Process Flow – Conventional Mining

## NaCl Tailings Rejected

- Halite (NaCl) remains hydrophilic under flotation conditions and does not attach to bubbles
- NaCl particles sink and are discharged as tailings, along with process water
- These salt tailings:
  - Represent the largest waste stream by volume
  - Are typically managed via surface tailings piles or underground backfilling
- Efficient rejection of NaCl is essential to:
  - Improve final product grade
  - Reduce downstream drying and handling costs

*Potash Tailings Management area*



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# Process Flow – Conventional Mining

**Drying → Compaction/Granulation → Storage & Shipping**

- Flotation concentrate is mechanically dewatered in centrifuges, then thermally dried using natural gas-fired dryers.
- Dried product is conditioned depending on market requirements:
  - Compaction: Fine material pressed into flakes and crushed to uniform granules
- Product is screened to meet size specifications and may be coated to:
  - Reduce dust
  - Minimize caking during storage and transport
- Finished potash is conveyed to:
  - Large on-site storage barns
  - Rail load-out facilities for shipment to domestic and export markets



Compacted potash flakes and granules

<https://ludman.net/compactors/>

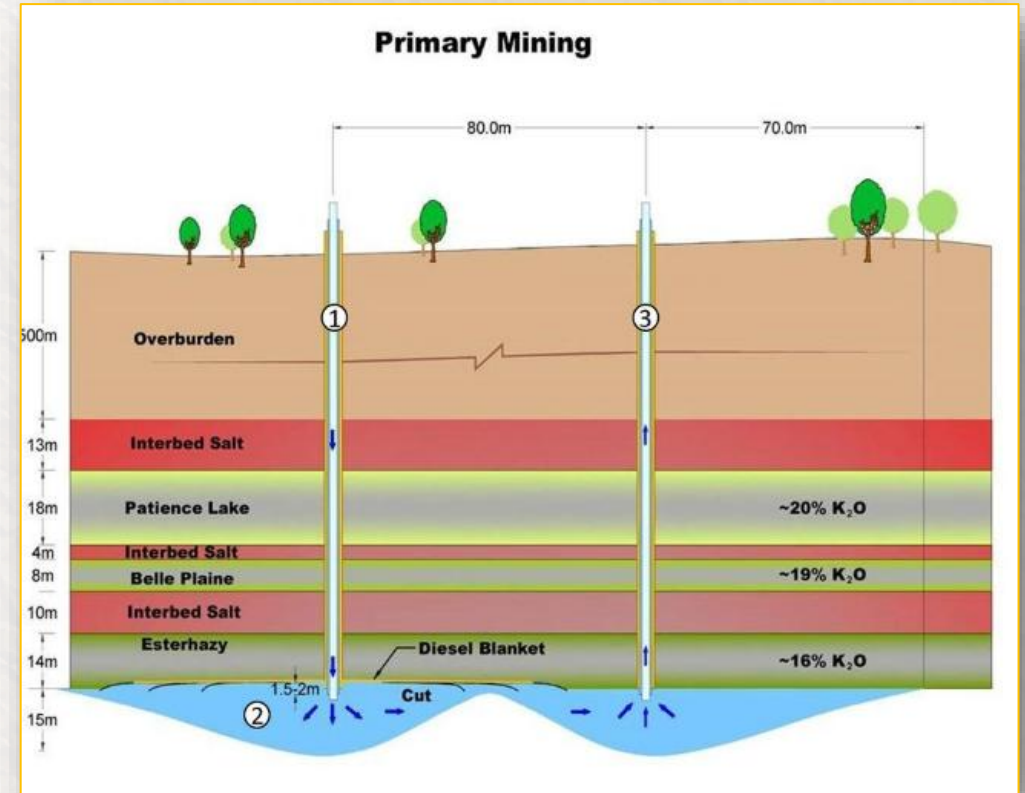


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# Mining Methods Used in Saskatchewan

## Solution Mining

- Applied where conventional underground mining is uneconomic or geotechnically challenging
- Hot sodium chloride (NaCl) brine is injected through wells to dissolve KCl from the ore body
- Potassium-rich brine is pumped to surface for processing
- Potash is recovered via crystallization rather than flotation



1) Injection Well 2) Dissolving 3) Extraction

[Source: Potash Mining - GensourceGensource](#)



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# Process Flow – Solution Mining

## Hot NaCl Brine Injected into Ore Zone

- Solution mining uses heated, saturated sodium chloride (NaCl) brine injected into the potash-bearing horizon through wells.
- The brine temperature is typically elevated to:
  - Increase dissolution rates
  - Improve potash recovery efficiency
- Injection and recovery wells are carefully spaced to control cavity growth within the ore body
- No underground workers or tunnels are required; all access is via surface wells

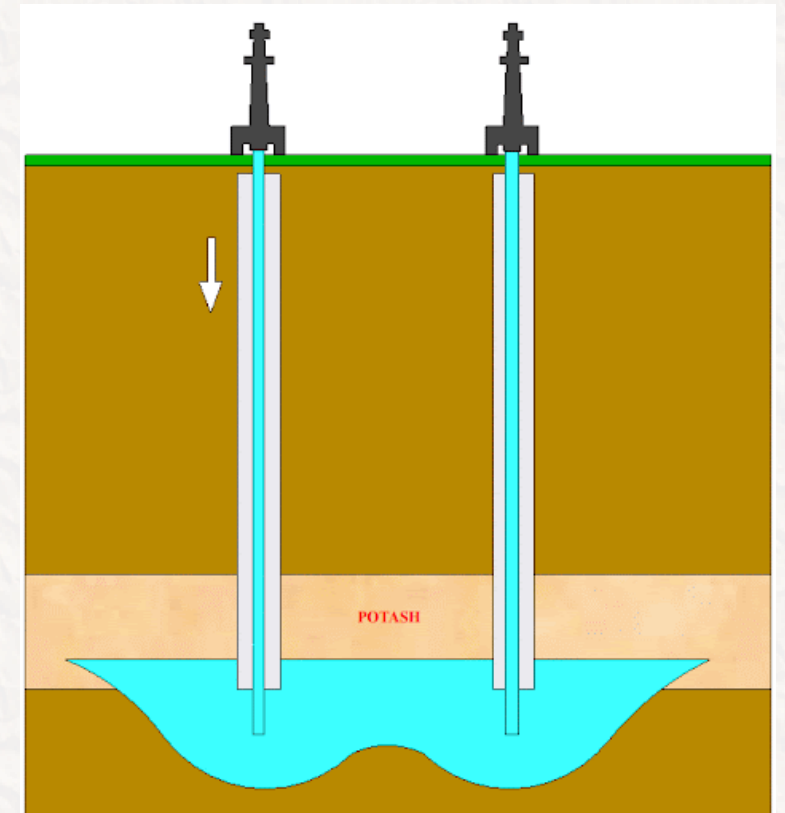


# Process Flow – Solution Mining

## Brine Pumped to Surface

- The potassium-rich brine is pumped back to surface through production wells
- At surface, potash is recovered using crystallization, not flotation:
  - Brine is cooled and/or evaporated
  - KCl crystallizes out of solution
  - Crystals are separated, dried, and processed into final product
- Residual brine is often reheated and reinjected, creating a closed or semi-closed brine loop.
- Surface facilities include:
  - Heat exchangers and boilers
  - Crystallizers and centrifuges
  - Dryers and product finishing systems

*Solution mining: Brine injection and extraction animation*



Source: Canada Golden Fortune Potash Corp



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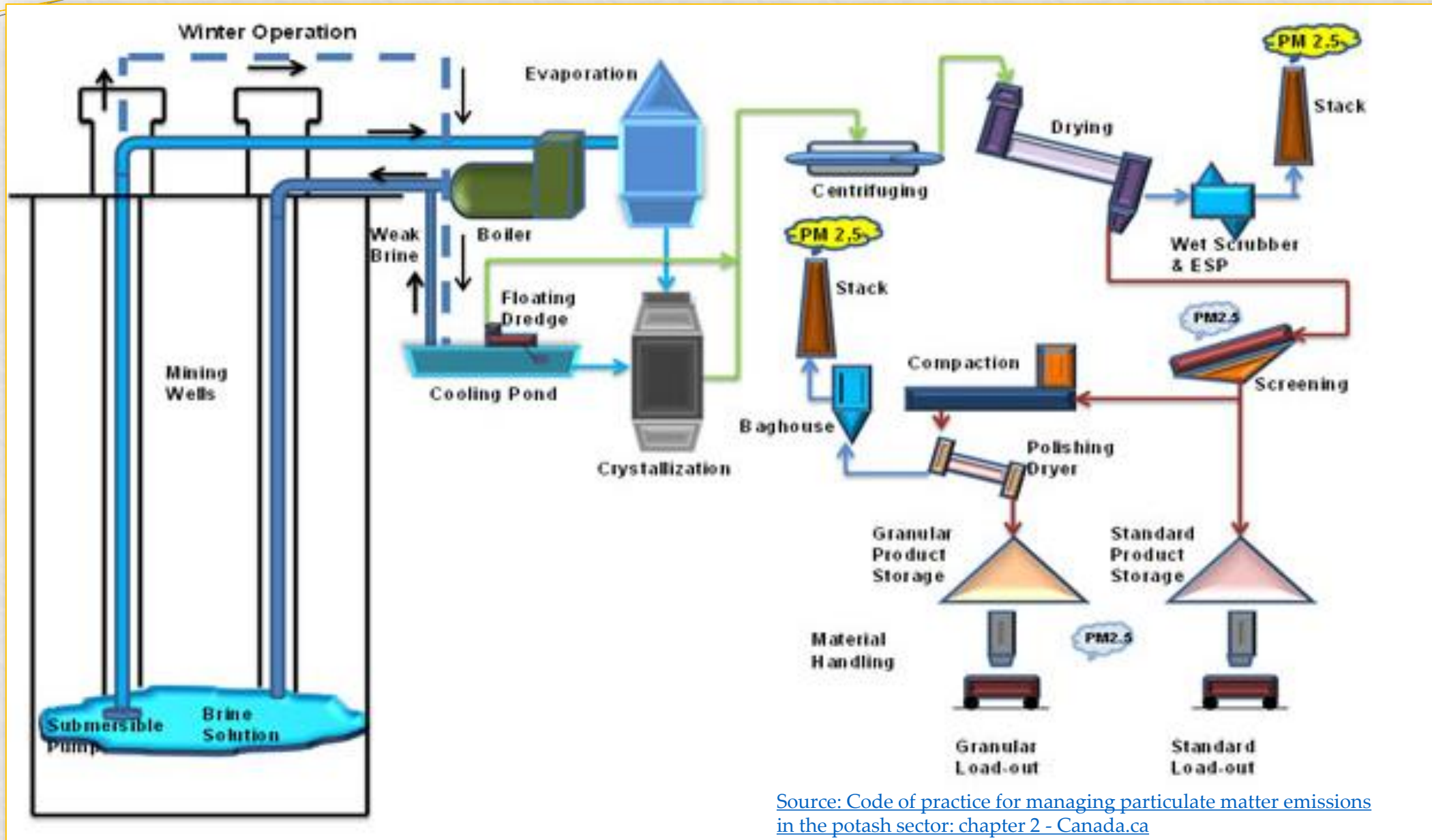
# Process Flow – Solution Mining

## Selective Dissolution of KCl

- The process exploits the different solubilities of KCl and NaCl at elevated temperatures.
- Because the injected brine is already saturated with NaCl:
  - Additional NaCl dissolves only minimally
  - Potassium chloride (KCl) preferentially dissolves into solution
- The result is a potassium-rich brine, while much of the halite remains in place
- Brine chemistry (temperature, concentration, flow rate) must be tightly controlled to:
  - Maximize KCl recovery
  - Maintain cavern stability
  - Avoid excessive dissolution of surrounding salt



# Solution Mining/Milling Process Flow sheet



Source: Code of practice for managing particulate matter emissions in the potash sector: chapter 2 - Canada.ca

# Mining Methods Used in Saskatchewan

## **Solution Mining**

### **Advantages:**

- No underground workforce
- Can access deeper or lower-quality deposits
- Lower upfront capital compared to shaft mining

### **Challenges:**

- High energy demand for heating brine
- Slower production ramp-up
- Complex brine chemistry and cavity control
- Generally lower recovery efficiency than conventional mining

