Grade 7: Earth's Crust and Resources

Lesson: Potash Solution Mining – Dissolving Potash

Overview

Students will discover through guided inquiry and hands on activities that one of Saskatchewan's valuable mineral resources is a mechanical mixture which is mined by conventional underground methods or by dissolution in water. The students will carry out activities to simulate the work of a Chemical Engineer/Geochemist/Chemist /Chemical technician and general operations personnel in determining how to mine potash deposits that are too deep to mine conventionally, how to separate the soluble minerals from the insoluble minerals.

Source: This lesson plan has been adapted from an activity developed by Murray Schultz (Chief Chemist, Mosaic Potash) for the SMA Teacher GeoVenture Tour and Showcase 2008, and from a lesson plan developed by Larry Bogdan (Teacher, Avonlea School, Prairie South School Division).

Duration: 3 classes

Materials:

- Clear glass canning jar(250ml) or glass beaker per group
- 250 ml measuring cup or graduated cylinder
- One litre container
- Lump of Potash (sylvinite) per group (approximately 3cm x 3cm)
- Room temperature water - 200 ml
- Weighing balance
- Coffee filter paper one per group;
- One plastic coffee filter holder or a large funnel (more would make the activity proceed more quickly)
- Spoon or plastic stir stick per group
- **Student Activity and Observation Sheet**
- **Teacher Activity and Observation Sheet Answers**
- **Photos**
- **Potash Solution Mining in Saskatchewan diagram**

Teacher Note:

This lesson is similar to the Potash Solution Mining Dissolving Potash lesson for the Mixtures and Solutions Unit. Some of the student questions are different.

Prior Knowledge:

Before attempting these activities students should have some understanding of the following: The use of water as a solvent

Instructional Methods:

- Brainstorming
- Discussion
- Small group work
- Guided inquiry
- Laboratory investigation

Dredge on cooling pond. Mosaic Potash Belle Plaine

Photo: Mosaic Potash Belle Plaine

Learning Outcomes and Indicators

EC7.2 Identify locations and processes used to extract Earth's geological resources and examine the impacts of those locations and processes on society and the environment.

- Distinguish between rocks and minerals using physical samples, pictures, and/or video recordings and identify the minerals most often found in rocks in Saskatchewan and around the world (e.g., quartz, calcite, feldspar, mica, hornblende). (EC7.2b)
- Classify rocks and minerals based on physical properties such as colour, hardness, cleavage, lustre, and streak.(EC7.2c)
- Relate processes used to extract primary mineral resources in Saskatchewan (e.g., open-pit mining, underground mining, and solution mining) to the location, type, and depth of the resource.(EC7.2e)

Source: **Saskatchewan Evergreen Curriculum**

Students will also:

- Discover that the potash mineral mined in Saskatchewan is a salt and can be mined and separated from other minerals through dissolution.
- Describe the characteristics of the mineral potash ore.
- Describe the methods used to separate minerals in the potash ore using dissolution and filtration.
- Ddescribe the concentration of student-prepared solutions using quantitative measurements.
- Carry out an activity to simulate the work of a Chemical engineer/Geochemist/Chemist/Chemical technician and general operations personnel in determining how to separate the valuable potash from the potash ore.
- Discover how Geochemists, Chemical Engineers, Chemists and Chemical technicians study and apply scientific knowledge related to solutions.
- Understand that the Geochemists, Chemical Engineers, Chemists and Chemical technicians work along with the general operations personnel (it is a team effort) in the development of mining methods for potash, monitoring the quality of the potash produced and helping to find new and better ways to improve production and processing of potash.

Big Picture Question

1. **How is potash mined if it is too deep in the ground to mine in the conventional underground method?**

Background Information

Potash is a general term covering several types of potassium salts, of which the most important is potassium chloride, the mineral sylvite (KCl). In Saskatchewan, potash is extracted from deep underground deposits (generally 1000 m or 1 km) using either conventional (mining machines) or solution mining (brine is used to remove the mineral in solution) techniques.

The largest potash solution mine in the world is in Saskatchewan. With this technique the potash is dissolved deep underground and the solution is pumped to the surface where the potash is removed. The same process can be used above ground to extract the potash from the sylvinite ore. After potash is mined, it is processed in a surface mill, where it is separated into product (KCl) and waste (tailings comprised of salt and clays).

In 2010 there were 10 potash mines in Saskatchewan; two are solution mines, and the remaining 8 are conventional underground mines that use machines to mine the ore.

Potash is a nutrient essential for plant growth, and is a main component of modern agricultural fertilizers. Roughly 95 per cent of world potash production goes into fertilizer, while the other five per cent is used in commercial and industrial products - everything from soap to television tubes.

Potash is a major export of Saskatchewan. It is transported by rail to the United States and to Canadian ports where it is shipped to other countries including China, Korea, Japan, Malaysia, India, Brazil and Australia. Canadian markets make up less than 5% of potash sales.

Safety concerns

- Do not eat potash sample
- Do not drink solution

Vocabulary

brine
dissolve
ore
soluble
sylvite
wasterock
density
halite
potash
solution
sylvinite

THE ACTIVITY

Dissolving Potash

(Brainstorming, Hands-on lab) (80 minutes)

Motivational Set (10 minutes)

Inform the students that they are working as Geochemists, Chemical Engineers, Chemists and Chemical technicians for a potash company and that it is their job to determine how to separate the valuable potash mineral from the potash ore. Explain that potash ore (sylvinite) is a mixture of halite (NaCl, table salt), sylvite (KCl), clays and iron minerals. Write the formulas for the two salts (NaCl (halite) and KCl (sylvite)) on the board. Discuss the properties of table salt (NaCl) guiding the students to the conclusion that it can be dissolved in water. Inform the students that sylvite (KCl) is also a salt., and that the potassium chloride is the valuable mineral that the mining company wants but has to determine a way to separate it from the clay and iron minerals before they can separate it from the halite.

Brainstorm various methods of separating the potash from the other undesirable insoluble minerals (clays, iron minerals).

The students should come up with the answer: by dissolving the salts and then separating the clay and iron minerals.

Part 1 (Observation of dissolution of potash) (30 min.)

1. Have students work in pairs.
2. Hand out Student Activity and observation sheet and have the students do the lab activity.

Part 2 Filtration of mixture (40 min.)

At the beginning of the next class have students record their observations prior to moving the jar/beaker to work station. Continue on with the lab.

1. Have students filter their mixtures by placing the filter in a coffee filter holder/funnel onto the one litre container and carefully pour all of their solution and the insoluble products into the filter. If insoluble particles remain in the jar/beaker use some of the solution to rinse them out.

The solution can be washed down the drain or collected in a bucket and disposed of down the drain at a later time. Filters will need to be left to dry, possibly over night.

If you are going to do the lesson *Recovering Dissolved Potash*, keep one litre of the filtered solution.

2. Have one person in the class weigh a clean dry filter. This weight will be used as a standard weight for all filters used.
3. When the student's filters are dry, have each group weigh their own filters with residue and record.
4. Students can then calculate the amount of the insoluble materials in their sample.
5. Students can complete the discussion questions.
6. Have students post their answers to Part 2 question 1 on the board. *As an extension students could do mean, median and range of values*.
7. Review the discussion questions.

Assessment Method and Evidence

✓Anecdotal notes and/or checklist

- Students will show an ability to work together in a cooperative learning environment.

✓Discussion questions:

- Students will be able to explain that the potash mineral mined in Saskatchewan is a salt which can be mined and separated from other minerals through dissolution in warm water and filtration.
- Students will be able to explain why it is important to know how much insoluble material is in the potash ore.

✓Calculation Sheet:

- Students will weigh their sylvinite samples and residue and calculate the percent of dissolved salts and insoluble materials (waste rock) in their sample using quantitative measurements.
- Students will be able to calculate the percentage of waste materials in their potash sample.

✓Observation Chart:

- Students will describe the sample of potash ore and the insoluble waste materials.

✓Journal Entry:

- Students will show their understanding of potash solution mining in Saskatchewan and what role the Geochemist/Chemical Engineer/Chemist plays in the production of potash.

Summary

In a combination of guided inquiry and hands on laboratory, students investigated how to mine potash deposits that are too deep to mine conventionally and how to how to separate the insoluble waste minerals from the soluble salt minerals which includes the

valuable potash mineral sylvite (KCl). This activity simulated some of the work of a Geochemist/Chemical Engineer/ Chemist/ Chemical technician and general operations personnel at a potash solution mine.

Extension Activities

1. Students could investigate a career as a Chemical Engineer, Chemical Technologist, Chemical Technician, Chemist, and Geochemist by going to Future Paths http://www.futurepaths.ca/storage/CareerTree-Mining.pdf

2. Have students investigate the uses of potash through a web search of Saskatchewan's potash companies:

Resources

Mining and milling processes used at the PotashCorp mines.
http://www.potashcorp.com/media/POT_Mini_Mine_Tour_brochure.pdf

Saskatchewan Potash Interpretive Centre:
http://www.potashinterpretivecentre.com/index2.htm

Saskatchewan Mining Association Website:
http://www.saskmining.ca

Potash Corporation of Saskatchewan Website:
http://www.potashcorp.com/

International Fertilizer Association Website:
http://www.fertilizer.org/ifa/default.asp

Agrium Website: http://www.agrium.com

The Mosaic Company Website:
http://www.mosaicco.com

Fuzesy, A. (1981): Potash in Saskatchewan; Saskatchewan Energy and Mines Report No.181, 44p.

Holter, M.E. (1969): The Middle Devonian Prairie Evaporite of Saskatchewan; Department of Mineral Resources-Geological Sciences Branch-Industrial Minerals Division-Province of Saskatchewan; Report No.123, 134p.

Teacher Answer Sheets Dissolving Potash

Background: Potash is one of the major exports of Saskatchewan. The potash minerals sylvite is a salt (KCl) that is found in the potash ore sylvinite. The mining companies need to separate the KCl from the rest of the ore in order to sell it.

Problem: How can the potash mineral (KCl) be separated from its ore? What properties are used to do this?

Hypothesis: (the hypothesis should be written as "if…then" and should include some explanation). Answer Question 1 in Discussion.

If we place the potash ore in water then the salts (potash) will dissolve and can be separated from the insoluble portion of the ore.

Materials: Clear glass canning jar(250ml) or glass beaker , Measuring cup or graduated cylinder, lump of potash (sylvinite), 200 ml room temperature water, thermometer, weighing balance, filter, paper, spoon.

Procedure:

Part 1.

1. Describe the potash sample a) dry, b) wet
2. Measure 200 ml of room temperature tap water into a 250 ml jar/beaker. Put your names on the jar.
3. Weigh your potash ore (sylvinite) samples. Record weight
4. Carefully place your sample of sylvinite into the jar/beaker. Do not shake or stir the jar/beaker.
5. Over a period of 10-30 minutes observe what is happening in the jar/beaker and record on your observation sheet. A drawing may be helpful.
6. Explain what is happening to the potash sample when it is immersed in the tap water.
7. Place jars/beakers in a safe place (shelf/counter) where they will not be disturbed until the next class. Make observations throughout the day or wait until the next science class. Record your observations including time and date.

Part 2

1. At the beginning of the next class record your observations before moving the jar/beaker.
2. Stir the mixture to break up any of the bigger pieces and record your observations.
3. Use a ball point pen to put your names on the coffee filter. Label the filter #1.
4. When your turn is called, place your filter into the coffee filter holder/funnel. Carefully stir the contents of the jar and pour it all into the filter trying to get all of the remaining material into the filter. If insoluble particles remain in the jar/beaker use some of the solution to rinse them out. DO NOT USE WATER.
5. Record your observations of the materials in the filter.
6. Leave the filters to dry until the next class.
7. Work on Discussion questions 2-4.

Part 3

1. Record the weight of the clean dry filter on your results sheet.
2. Weigh your own filter with residue and record (see Calculations sheet)
3. Determine the amount of the dissolved salts and the insoluble materials in your sample. See the calculations on your results sheet.
4. Complete the discussion questions.

Results:

Part 1.		
Weight of filter		
Weight of sample		
OBSERVATIONS		
Time	**Observations**	

Description of dry sample
How many minerals can you see?
Describe them using: colour, hardness, cleavage, habit (shape) lustre, cleavage

colour	*Hardness*	*cleavage*	*Habit/shape*	*lustre*	*Opaque or translucent*
Red-orange Iron oxide	*<2*	*Not visible*	*No real shape occurs in between other minerals*	*Dull, earthy*	*opaque*
White Halite or sylvite	*2-2.5*	*At 90°*	*May be able to see a cubic shape*	*Dull to glassy (vitreous)*	*Opaque – Translucent, milky*
Colourless (clear - will look greyish) Halite, sylvite	*2-2.5*	*At 90°*	*May be able to see a cubic shape*	*glassy*	*transparent*
Grey –Beige clays	*<2*	*Not visible*	*No real shape occurs in between other minerals*	*Dull, earthy*	*opaque*

Description of wet sample You should be able to see the minerals a bit better. Add any other descriptions.	
Start to 5 minutes	*Tiny bubbles rise to the top, the colours of the sample are more distinct, tiny white flecks like dust moved off the sylvinite and sank, white flecks are rising to the surface.* *Looking closely at the face of the potash ore there is a "wavy, flowing" look. This is the salt on the edge of the sample dissolving in the water. As the water dissolves the crystals you will see small cloud like eddies form which appear to fall down to the bottom of the beaker.*
10 to 15 minutes	*Larger red particles are rising and sinking, most particles are less than a millimetre, the surface of the ore is rougher and the clearer crystal part seems to be disappearing, there is a reddish layer about the same depth as the top of the ore and when sinking red particles hit this layer they stop sinking.*
20 to 25 minutes	*Larger flakes are rising and sinking, the ore looks rough, red and grey, red flakes are accumulating on the surface, very little clear crystal is visible.*

30 – 35 minutes	*Lots of sediment is on the bottom around the remaining ore, more red particles rising and sinking, more particles suspended at a level near the top of the ore and not moving.*
Other observations	
Part 2. Next Day Description of materials in the jar	*There are many air bubbles attached to the sides of the jar/beaker, some red flakes are floating on the surface, some are suspended in the clear liquid, there doesn't appear to be a reddish liquid zone near the bottom anymore, where the ore was on the bottom there is now a layer of red and grey sediment, all of the clear crystals are gone.*
Description of materials in the filter (residue)	*The residue is reddish with some grey materials. When dry it looks pink, powdery with some oddly shaped white particles. (See photos)*

Calculations:

Weight of residue and filter paper: _____
- Weight of filter paper: _____

Weight of residue =_____ (the minerals (insolubles) that did not dissolve in the water)

Weight of sylvinite ore: _____
- Weight of residue: _____

= _____ Weight of dissolve salts

% dissolved salts = (weight of dissolved salts/total weight of sylvinite sample X 100) = _____

% of insolubles = (weight of dry residue/total weight of sylvinite sample X 100) = _____

The insoluble material is the waste rock. Mining companies do not make money from waste rock, so the less there is in the ore the better.

Discussion Questions: (answer in full and complete sentences)

Activity 1 Part One

1. What is your hypothesis?
   If we place the potash ore in water then the salts (potash) will dissolve and can be separated from the insoluble portion of the ore.

2. Examine your sample of potash ore a) dry and b) slightly wet.
   Is this a rock or mineral? *Rock*
   Explain why. *Because it is made up of different minerals.*

   How many different substances can you see or find in your sample?
   Students should have three or four substances in their samples. A red mineral (iron oxide), grey mineral (clay), clear grey/white mineral and a cloudy or milky white mineral (the salts NaCl and KCl). Sylvinite is a mixture of different minerals that grew together when they formed. When the ore is under water it becomes more apparent that it is made up of different substances with different colours. Red particles, grey particles and the shiny crystals.

3. What properties helped you decide that the substances were different? Explain.
   Ore samples vary so the descriptions will also vary. Properties used will be colour, hardness, clarity (translucent, transparent (clear) or milky), lustre (shininess), and crystal structure (or shape).

Part Two and Three

1 What percent of the sylvinite is insoluble? What percent is soluble? (See your calculation)
Answers will vary. The salts are the soluble part of the potash ore. The insoluble part or waste rock is made up of clay and iron oxides.

2. How do your answers for question 1. compare with your classmate's answers? *Answers should vary somewhat. As an extension have the class do mean, median and range of values. As the potash ore is a mixture (halite, sylvite, clay and iron oxides) the amounts of each will vary depending upon the conditions that the minerals were precipitated in and where the rock is located in the mine (e.g. close to the edges of the mine where the ore contains more waste rock or in the area of high grade (more pure ore).*
3. Your piece of sylvinite was just a small sample of a potash ore body. Why do you think it is important to know how much of the sample is soluble or not?
   It is important for the mine engineers to know how much of the samples are waste (the insoluble part) so that they can design where to mine. They want to find the rock with the most KCl or ore because it is valuable where as waste rock is not.

Conclusions:
Your conclusion should include:
a) How the potash minerals were separated from the rest of the potash ore.
The salt minerals in potash ore can be separated from the ore by dissolving the ore in water and passing it through a filter. The salts KCL and NaCl are soluble in water.

Science Journal Questions:

1. Why is potash so important?
   Potash is used in fertilizers as well as in TV. picture tubes, glass, rocket fuel, water softener, drilling mud, and to melt ice.
   The potassium, that comes from the potash, helps plants use water and resist drought. Potassium is important to food crops and enhances the size of fruits and vegetables. It is called the regulator of plants.
2. What is one of the jobs the potash company Geochemist/Chemical Engineer/Chemist does?
3. What courses do you think these scientists/technicians need to be good in?
4. What information have you learned in grade 7 science that would help you have a career with a potash company?
5. Is this a career that you might be interested in?

Student Activity Sheet Dissolving Potash

Background: Potash is one of the major exports of Saskatchewan. The potash mineral sylvite is a salt (KCl) that is found in the potash ore sylvinite. The mining companies need to separate the KCl from the rest of the ore in order to sell it.

Problem: How can the potash mineral (KCl) be separated from its ore? What properties are used to do this?

Hypothesis: (the hypothesis should be written as "if…then" and should include some explanation). **Answer Question 1 in Discussion**.

Materials: Clear glass canning jar(250ml) or glass beaker , Measuring cup or graduated cylinder, lump of potash (sylvinite), 200 ml room temperature water, weighing balance, filter paper, spoon.

Procedure:

Part 1.

1. Describe the potash sample a) dry, b) wet
2. Measure 200 ml of room temperature tap water into a 250 ml jar/beaker. Put your names on the jar.
3. Weigh your potash ore (sylvinite) samples. Record weight
4. Carefully place your sample of sylvinite into the jar/beaker. Do not shake or stir the jar/beaker.
5. Over a period of 10-30 minutes observe what is happening in the jar/beaker and record on your observation sheet. A drawing may be helpful.
6. Explain what is happening to the potash sample when it is immersed in the tap water.
7. Place jars/beakers in a safe place (shelf/counter) where they will not be disturbed until the next class. Make observations throughout the day or wait until the next science class. Record your observations including time and date.

Part 2

1. At the beginning of the next class record your observations before moving the jar/beaker.
2. Stir the mixture to break up any of the bigger pieces and record your observations.
3. Use a ball point pen to put your names on the coffee filter. Label the filter #1.
4. When your turn is called, place your filter into the coffee filter holder/funnel. Carefully stir the contents of the jar and pour it all into the filter trying to get all of the remaining material into the filter. If insoluble particles remain in the jar/beaker use some of the solution to rinse them out. DO NOT USE WATER.
5. Record your observations of the materials in the filter.
6. Leave the filters to dry until the next class.
7. Work on Discussion questions 2-4.

Part 3

1. Record the weight of the clean dry filter on your results sheet.
2. Weigh your own filter with residue and record (see calculations)
3. Determine the amount of the dissolved salts and the insoluble materials in your sample. See the calculations on your results sheet.
4. Complete the discussion questions.

Name:_____

Results:

Part 1.		
Weight of filter		
Weight of sample		
OBSERVATIONS		
Time	**Observations**	
Description of dry sample How many minerals can you see? Describe them using: colour, hardness, cleavage, habit (shape) lustre, cleavage		
Description of wet sample You should be able to see the minerals a bit better. Add any other descriptions.		
Start to 5 minutes		
10 to 15 minutes		
20 to 25 minutes		
30 – 35 minutes		
Other observations		

Part 2. Next Day Description of materials in the jar	
Description of materials in the filter (residue)	

Calculations:

Weight of residue and filter paper: _____
- Weight of filter paper: _____

= Weight of residue: _____ (the minerals that did not dissolve in the water)

Weight of sylvinite ore: _____
- Weight of residue: _____

= Weight of dissolved salts: _____

% dissolved salts = (weight of dissolved salts/total weight of sylvinite sample X 100) = _____

% of insolubles = (weight of dry residue/total weight of sylvinite sample X 100) = _____

The insoluble material is the waste rock. Mining companies do not make money from waste rock, so the less there is in the ore the better.

Discussion Questions: Name: _____

Part One

1. What is your hypothesis?

2. Examine your sample of potash ore a) dry and b) slightly wet.
   Is this a rock or mineral?
   Explain why.

   How many different substances can you see or find in your sample?

3. What properties helped you decide that the substances were different? Explain.

Part Two and Three

1 What percent of the sylvinite is insoluble? What percent is soluble? (See your calculation)

2. How do your answers for question 1. compare with your classmate's answers?

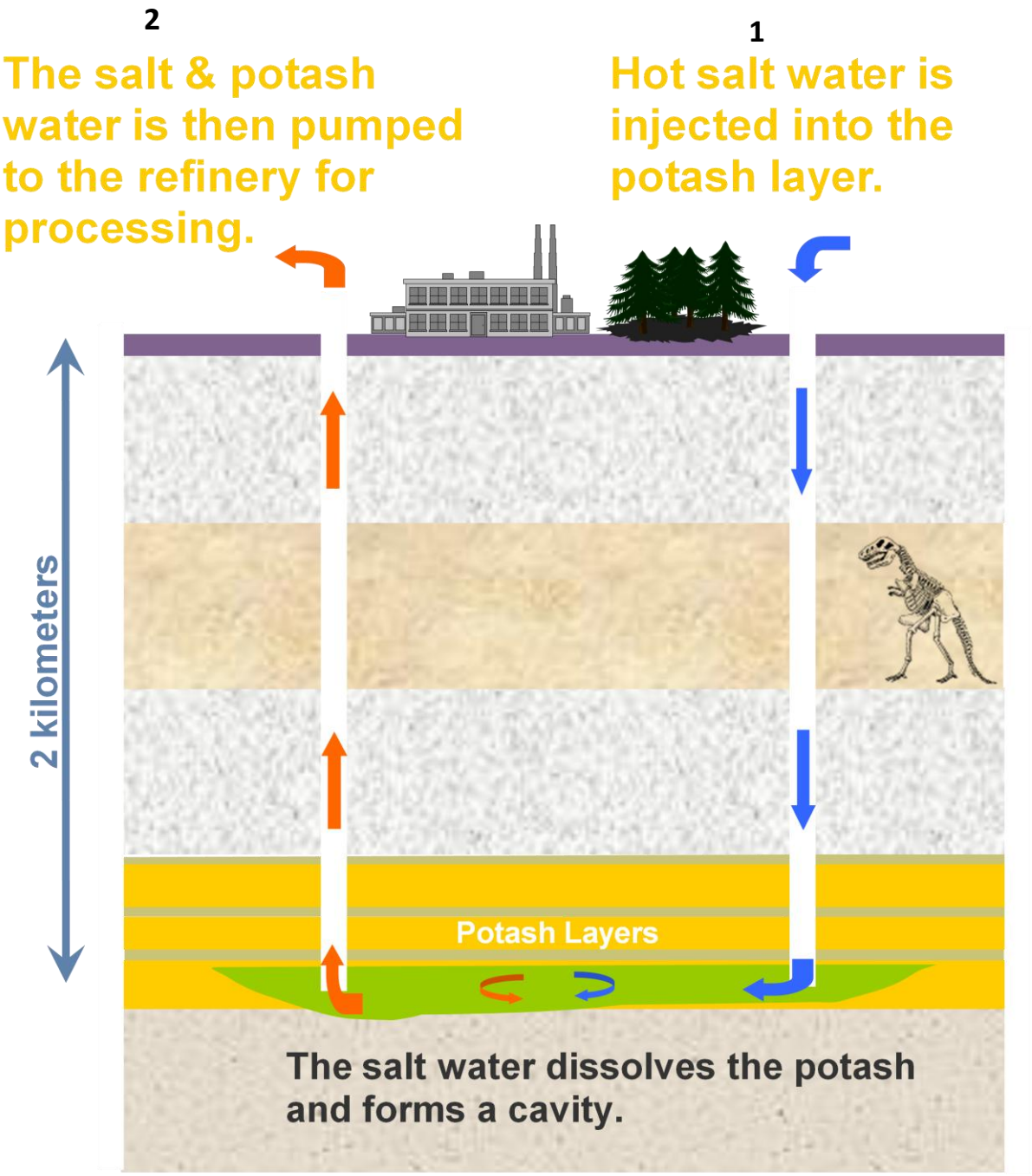
3. Your piece of sylvinite was just a small sample of a potash ore body. Why do you think it is important to know how much of the sample is soluble or not?

Conclusions:
Your conclusion should include: a) How the potash minerals were separated from the rest of the potash ore.

Science Journal Questions:

1. What is one of the jobs the potash company Geochemist/Chemical Engineer/Chemist does?
2. What courses do you think these scientists need to be good in?
3. What information have you learned in grade 7 science that would help you be a geochemist for a potash company?
4. Is this a career that you might be interested in?

Potash Solution Mining in Saskatchewan



From: Mosaic Potash PowerPoint –Showcase Belle Plaine

Vocabulary

Brine: Water saturated with or containing large amounts of a salt, especially sodium chloride. The water of a sea or an ocean is a brine.

Density: The measure of the compactness of a substance, expressed as its mass per unit volume.

Dissolve: To break into component parts to become incorporated into a liquid so as to form a solution.

Halite: Sodium chloride (NaCl) as a mineral, typically occurring as colourless cubic crystals; what we know as salt.

Ore: Is rock that contains important minerals including metals**.** The ore is extracted through mining and processed to extract the valuable element(s). Ore contains minerals that can be mined at a profit.

Potash: Is Saskatchewan's provincial mineral. Potash is the common name for the potassium rich ore mined in Saskatchewan. It is made up of the minerals sylvite, halite, sometimes carnallite, clay and iron oxides.

Soluble: A substance is soluble if it can be dissolved into a liquid.

Solution: A liquid with something dissolved in it. It is a homogeneous mixture composed of two or more substances. In such a mixture, a **solute** is dissolved in another substance, known as a **solvent**.

Sylvinite: is the most important ore for the production of potash in North America. It is a mechanical mixture of sylvite (KCl, or potassium chloride) and halite (NaCl, or sodium chloride).[t]

Sylvite: is potassium chloride (KCl) in natural mineral form. It forms very similar to normal rock salt, halite (NaCl). Sylvite is colorless to white with shades of yellow and red due to inclusions. It has a Mohs hardness of 2.5. Sylvite has a salty taste with a distinct bitterness. Sylvite is one of the last evaporite minerals to precipitate out of solution. As such, it is only found in very dry saline areas. Its principal use is as a potassium fertilizer.

Waste rock: Barren or submarginal rock or ore that has been mined, but is not of sufficient value to warrant treatment and is therefore removed ahead of the milling processes.

Source:

Wikipedia. Available at: http://en.wikipedia.org/wiki/

Dictionary of Mining, Minerals and Related Terms. Available at: http://xmlwords.infomine.com/xmlwords.htm

Oxford English Dictionary on-line: Available at: http://oxforddictionaries.com

Yahoo Kids: Available at: http://kids.yahoo.com/reference/dictionary/english/

Photos

Sylvinite, potash ore sample – dry. Look as the size of the minerals. You should see red (iron oxide), grey-brown (clay), clear and white minerals (salt minerals halite and sylvite)

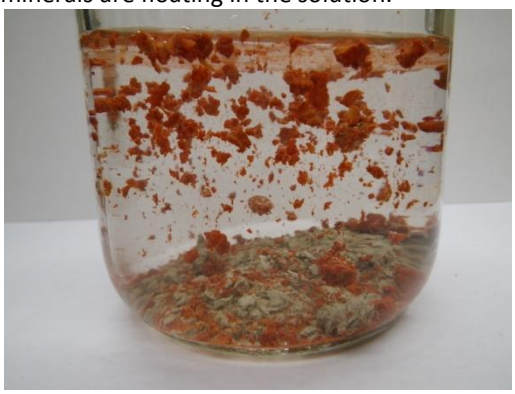
Sometimes it is easier to see the minerals if the sample is wet.

When the sample is first put into the water it will start to dissolve making the water cloudy. Some of the iron oxide minerals will start to float to the top of the water.

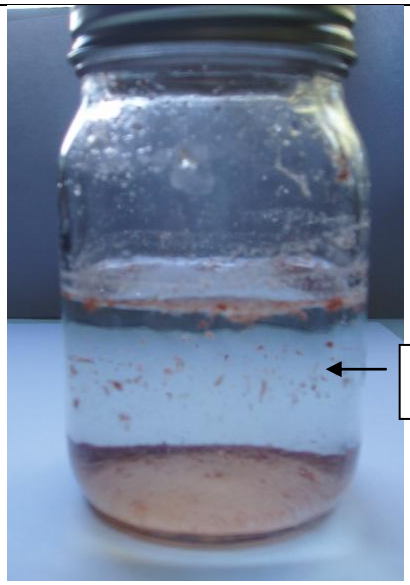
You will see the clay mineral start to fall apart in little clum[s. You may also see air bubbles on the sample. This is air that was attached to the sample as it went into the water or may be some air being released from small fractures or holes in the sample.

Potash ore sample dissolving. The clay (grey – brown minerl and the iron oxide mineral are visible but **where are the salt minerals?**

This sample has a lot of clay (grey – brown. It has dissolved into little chunks while the red oxided minerals are floating in the solution.



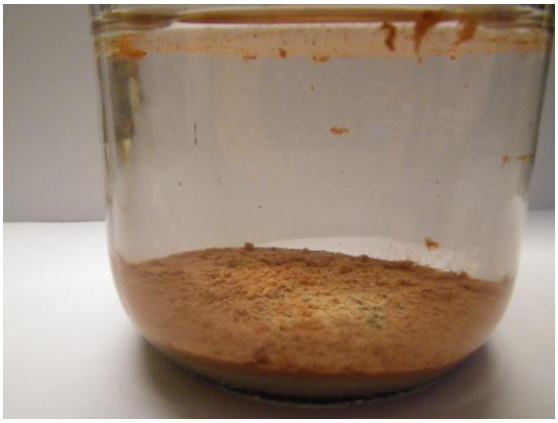
Eventually the solution clears. Some of the red oxide has sunk to the bottom and some remains floating on the surface of the solution.

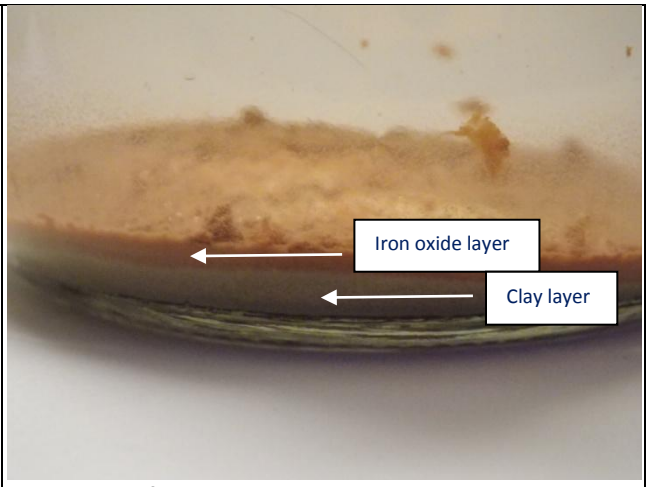


Occassionaly you may see the development of density layering. The iron oxides are floating on the more dense salt-water solution.

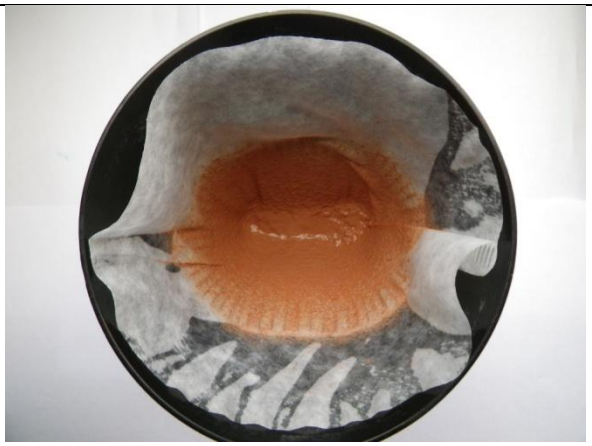
To break up the clumps of clay shake the jar (with the lid on) or stir.

Once the sediment has settle you will see layering with the heavier clay minerals on the bottom and the lighter oxide minerals on top as well as floating on the surface of the solution.



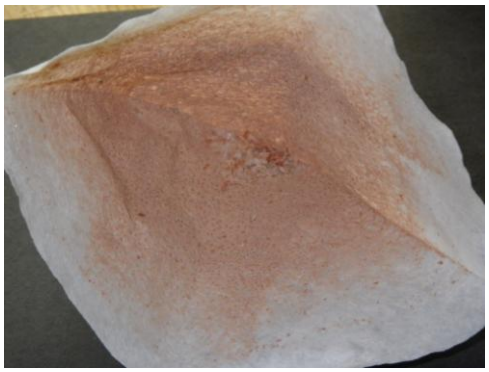


A close up of the sediment layers.



The unsoluable minerals left in the filter. Wet.

The filtered material is fine grained but when dried may have some crystals. Fine material is the clay and iron oxide minerals (reddish). Larger white grains are salts.



When the residue is dry the minerals that crystallized can be irregular in shape.