# Saskatchewan's Mineral Resources

## Lesson: Exploring for Minerals in Saskatchewan: Geophysics – Using Magnetics to Find a Mine

**Overview**
In this activity, students use the magnetic properties of iron nails to search for them in a tray of sand.

**Source:** This lesson has been modified from a lesson developed for Oresome Resources.

**Duration:** one class

**Materials:**
Per group
- Three 75 millimetre iron nails
- Tray of sand (preferably square)
- Compass
- Two copies of grid maps
- Ruler
- Permanent magnet.
- Dry erase marker or water soluble marker

**Using Magnetics to Find a Mine**
**Map of Exploration Area**
**Teacher Answer Sheet**
**Colour Overheads – Figures 1 - 4**

**Instructional Methods:** Guided Inquiry, hands on


Aerial Magnetometer Survey

## Learning Outcomes and Indicators

**Grade 7 Earth's Crust and Resources**
**EC7.2Identify locations and processes used to extract Earth's geological resources and examine the impacts of those locations and processes on society and the environment.**
f. Provide examples of technologies used to further scientific research related to extracting geological resources (e.g., satellite imaging, magnetometer, and core sample drilling).
g. Evaluate different approaches taken to answer questions, solve problems, and make decisions when searching for geological resources within Earth (e.g., trial-and-error prospecting versus core sampling).

**Earth Science 30: Lithosphere**
**ES30-LS3 Investigate the processes and technologies used to locate and extract mineral resources and fossil fuels locally, provincially and globally.**
d. Contrast the operation and utility of different imaging methods (e.g., gravity, magnetics, electromagnetics and seismic) for locating hard rock and soft rock resource deposits.
e. Identify anomalies from actual geophysical surveys and geologic maps and relate them to structural features and resource deposits.

Source: **Saskatchewan Evergreen Curriculum**

## Big Picture Questions

1. **How do they find mineral deposits in Saskatchewan?**

## Background Information

Geophysical methods are used to measure the physical properties of rocks at or below the Earth's

surface.

Geophysicists look for differences in the density, magnetic properties and electrical conductivity of rocks. The levels of natural radioactivity and the speed with which sound can travel through rocks are also measured.

### Types of surveys

Geophysicists collect information using equipment on the ground and from aircraft to measure the make-up of rocks found both on and under the surface. Ground geophysical surveys can be expensive and are generally undertaken only over relatively small areas of particular interest.

Airborne surveys are conducted using fixed-wing aircraft or helicopter normally flying 60 to 200 metres above the surface.

### Ground magnetic survey

The Earth acts as a giant magnet and influences mineral deposits that are magnetic or may be magnetised particularly objects containing iron. Magnetometers measure the magnetic field.

Magnetic surveys may be undertaken from the air or on the ground. The data can be presented as a magnetic map using computer technology.

### Electrical properties

Mineral deposits have a wide variety of electrical properties, including its electrical conductivity and capacity to hold an electric charge. These properties are measured by inserting electrodes into small holes dug in the ground, connecting them to a generator and running an electric current through the ground. Other methods include electro-magnetics, which can be measured on the ground, down drill holes or from aircraft.

### Seismic methods

Seismic surveys measure the speed sound travels through rock under the surface. It shows changes in porosity and permeability density. Sound waves are reflected at the surface of the denser rock. Different rock types and geological structures affect these seismic waves in specific ways; and by studying the results obtained, the shape and structure of layers under the Earth's surface can be predicted.

Seismic methods are commonly used in exploring for oil, potash and are now being used in the search for uranium.

### Radiometric surveys

Many rocks and minerals are naturally radioactive. In fact, almost everything has some level of radioactivity—even us! This is due to small concentrations of radioactive elements like potassium and uranium. Radiometric surveys measure variations in the natural radioactivity of the Earth's surface. Modern spectrometers enable radioactivity to be detected at very low levels not previously detectable. These surveys are normally done from the air, the ground and down all holes.

## Vocabulary

geophysics kimberlite

## THE ACTIVITY

**Teacher Prep:**

1. Before starting, ensure iron nails are magnetic enough. If the field is too weak, students can magnetise nails by rubbing them on a permanent magnet. Paperclips or small magnets could also be included to give a range of magnetic field strengths.
2. Copy the Map of The Exploration Area onto overheads. Make sure the grid area fits over the square container of sand. These can be used over again as long as students us dry erase or water soluble overhead markers.

**Motivational Set** ( 5 minutes)

**COOL FACT:** Some geophysical exploration techniques (for example, magnetics) originated from military technology used to search for submarines underwater.

**Explain:** The Earth acts as a giant magnet and influences minerals that are magnetic or may be magnetised, particularly objects containing iron.

Magnetometers measure changes in the magnitude of a magnetic field.

Magnetic surveys may be undertaken from the air or on the ground. The data are presented as a magnetic map using computer technology.

Tell the students that they will be looking for buried object s without disturbing the land.

**Activity:**

1. Check the magnetism of the nails using the compass to ensure their magnetic field is strong enough.
2. Hand out the sheets **Using Magnetics to Find a Mine** and **Map of The Exploration Area**
3. Have students work in pairs to complete the hands on activity. Students will work in pairs to hide the iron nails and exchange their nails with another group. The students will then work together to find the location of the nails hidden by the other group. Have the students take turns using a magnet to locate the iron nail while the other is plotting the location.
4. When the hands on portion is complete students can answer the questions.
5. Take up the questions.
6. Saskatchewan Connection: Show the students the magnetic map of Saskatchewan (Figure 1). Try to find your city/town.

Explain that the magnetometer locates rocks with magnetite and other magnetic minerals in them. The higher the amount of magnetite the brighter the colour. Pink and red areas have the most magnetite call magnetic highs. The blue areas have little to no magnetite, called magnetic lows. When looking for ore deposits one of the methods used is the magnetometer survey.

In Saskatchewan magnetometer surveys have helped to locate deposits of diamonds. Diamonds are found in an area east and north-east of Prince Albert (Figure 2). Although there are a lot of rocks with a magnetic signature (the long red/pink bands) diamonds are not found in all of them. Diamonds are associated with very small, roundish magnetic highs, usually around 100 m across. The small size of these deposits makes them very difficult to find. On the magnetic maps these deposits look like little bulls eyes (Figure 3) this is because the diamond pipe is most often a vertical pipe of rock with magnetite in it. (Figure 4).

## Assessment Method and Evidence

✓ **Hands on Activity**

- Students will understand and be able to describe how deposits with magnetic minerals can be located using magnetic surveys.
- Students will be able to provide information about magnetic surveys as an example of a technology used to further scientific research related to extracting geological resources

✓ **Discussion Questions**

- Students will evaluate different approaches taken and will be able to determine the most advantageous path to take when searching for geological resources using the magnetic survey as a tool.

## Resources

Fugro Airborne Surveys. Available at: http://www.fugroairborne.com/

**Oresome Resources** Available at: http://www.oresomeresources.com/resources_view/resource/publication_the_science_of_mining/section/resources/parent//category/exploration

## Vocabulary

**Geophysics:** A branch of physics dealing with the Earth, including its atmosphere and hydrosphere. It includes the use of seismic, gravitational, electrical, thermal, radiometric, and magnetic phenomena to interpret Earth data.

**Kimberlite:** This is the rock diamonds are found in but only a small percentage of the known kimberlite occurrences are diamondiferous. It is commonly brecciated and occurs in vertical pipes, dikes, and sills.

## Using Magnetics to Find a Mine

The Earth acts as a giant magnet and influences minerals that are magnetic or may be magnetised, particularly objects containing iron. Magnetometers measure changes in the strength of a magnetic field. Magnetic surveys may be undertaken from the air or on the ground. The data are presented as a magnetic map using computer technology. This information can be used to help find mineral deposits associated with magnetite. Magnetic surveys can also help map geological units and faults. This activity simulates how a magnetometer would find an ore deposit associated with magnetic minerals and buried deep underground.

### Method

1. Check the magnetism of the nails using the compass to ensure their magnetic field is strong enough. If not, magnetise the nails by rubbing them along a permanent magnet.

2. Without showing the group you are to exchange with, you will hide the three nails in the tray of sand. Place the nails on top of the sand then place the grid map over the sand box and mark the location of the nails on your map. Push the nails into the sand making sure they are between two and three centimetres deep. Smooth out the surface.

3. When the surface is flat, mark north in the sand.

4. Exchange your mineral deposit (BUT NOT THE MAP) with another group.

5. Your task is to locate the three nails using the compass and without disturbing the sand. Mark the nail location (and how they are trending) on the second grid map you were given.

6. When you think you have found and mapped all the nails ask for the location map from the other group and check if you were right

7. Check the locations using a pencil to probe.

8. Answer the discussion questions.

Name: _____

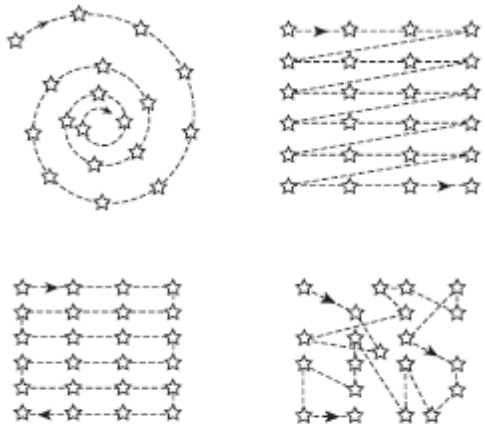
## Discussion Questions

1. What property of the nails was being used to allow them to be located?

2. What sort of mineral deposits can be explored this way?

3. What are some advantages and disadvantages of exploring for underground mineral deposits in this manner?

4. Below are some patterns a survey could follow. Each place where a measurement is taken is marked with a star. Which pattern do you think is the most efficient way to conduct the survey? Explain why.



Source: Department of Mines and Energy South Australia, 1996, *Resources: Working for the Right Balance*, Adelaide Institute of TAFE

## Conclusion

What did your results show? What worked well? What didn't work well? Suggest changes to the experiment.

# Map of the Exploration Area

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |

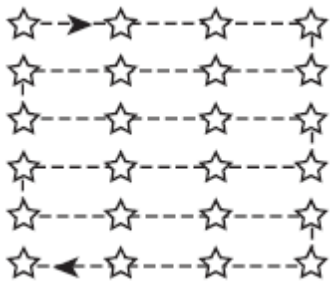
## Answers to Discussion Questions

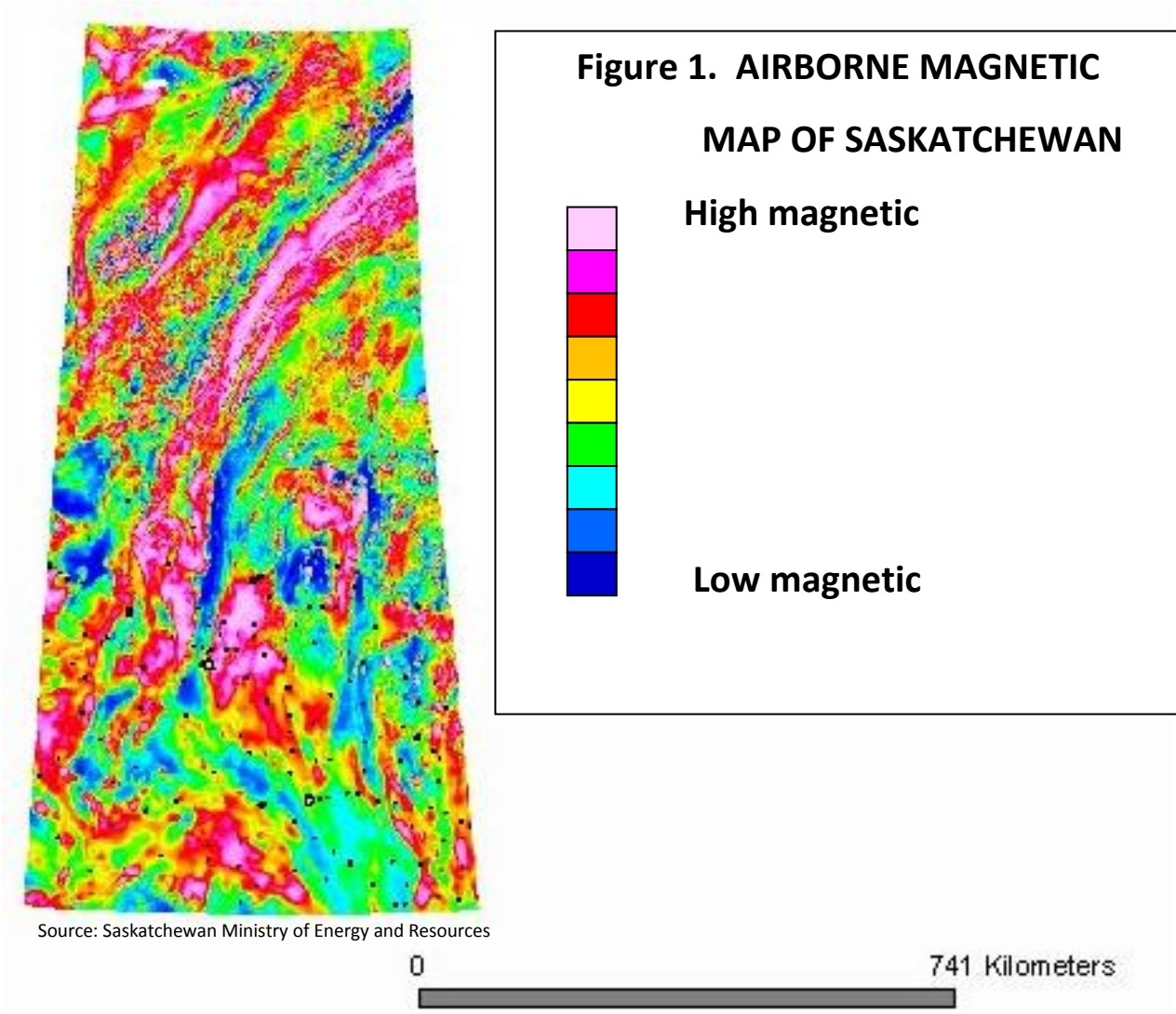
1. What property of the nails was being used to allow them to be located?
   Magnetism.

2. What sort of mineral deposits can be explored this way?
   Ore deposits containing magnetic minerals; for example, magnetite. Another magnetic mineral is pyrrhotite which looks similar to pyrite.

3. What are some advantages and disadvantages of exploring for underground mineral deposits in this manner?
   Advantages: a wide area can be covered using a plane or satellite.
   Disadvantages: not all deposits contain useful amounts of magnetic minerals; not all magnetic anomalies contain ore-bearing minerals; expensive; still need to drill to confirm ore is present.

4. Below are some patterns a survey could follow. Each place where a measurement is taken is marked with a star. Which pattern do you think is the most efficient way to conduct the survey? Explain why.
   The diagram with the straight lines is the most efficient way to conduct the survey. You travel less distance, and the measurements are taken in an ordered method.





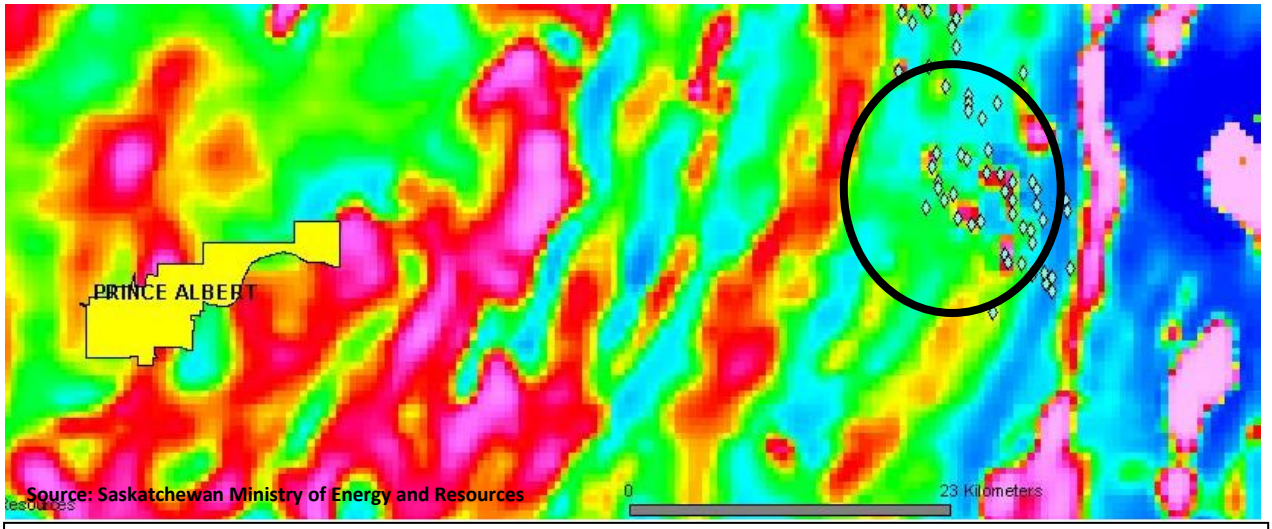




Figure 2. Kimberlites (diamond bearing rocks) have been found east of Prince Albert. These diamond bearing rocks were found by conducting airborne and ground magnetic surveys. Kimberlites (little blue diamond shapes) are shown associated with small magnetic highs.

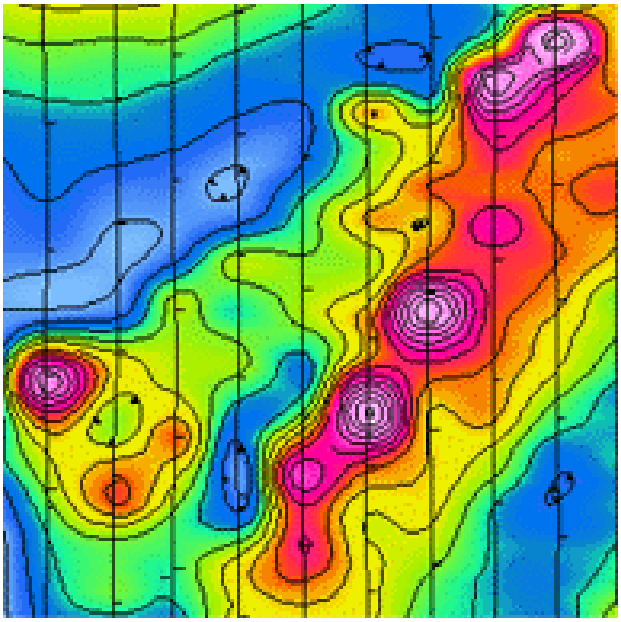
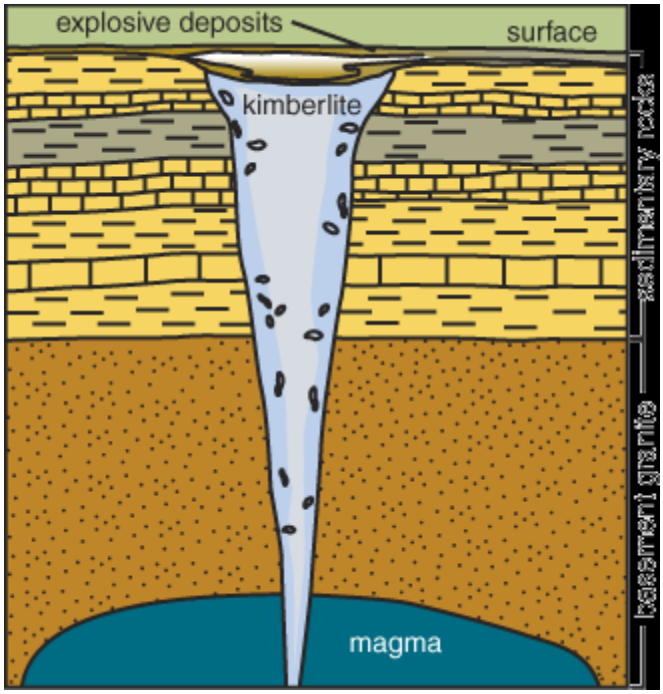


Figure 3. This magnetic map is looking at the ground as if from an airplane. The circular magnetic highs represent the kimberlite pipe. This is the diamond bearing pipe that goes deep into the ground.

They are usually very small, generally less than 100 metres across, which makes them very difficult to find.




Source: Kansas Geological Survey – Geological Record Available at: http://www.kgs.ku.edu/Publications/GeoRecord/2000/vol6.1/Page1.html

Figure 4. Kimberlite pipes are typically steeply dipping, with surface dimensions of several hundred metres. A diameter of 400 metres or more is considered large; less than 100 metres, small.

The magnetic minerals associated with diamonds occur within the pipe producing a round magnetic signature on the magnetic maps.