Resource Extraction Cycle

Resource Extraction Cycle

Exploration

Goal:

Locate deposits of rocks, minerals and petroleum that could be mined to support the global needs for materials.

Challenge:

Deposit location depends on geology.
Deposits are only located in a few spots around the world.
Most of the easy to find and access deposits have already been found and mined.
Deposits are hard to find and confirm.
Locate deposits efficiently and in a timely manner.
Methods need to keep the ecosystem sustainable.
Environment needs to be protected.

How to meet these goals:
Staged Exploration of preliminary exploration followed by advanced exploration.

Use broader, larger area, less invasive and cheaper methods before using more invasive and expensive focused methods.

Preliminary Exploration

Review of resources
Aerial geophysics
Prospecting
Chemical Surveys

Advanced Exploration

Land purchase
In-depth geophysics studies
In-depth geological studies
In-depth geochemical studies
Environmental studies
Preliminary Closure
Drilling
Road Building

Preliminary Exploration

Review of resources
Aerial geophysics
Chemical Surveys
Prospecting

Each type of rock and mineral has specific conditions in which it forms. The first step is to look for geology that might suggest conditions that could have formed a rock, mineral or petroleum deposit.

1) Review of Existing Resources

geology maps,
remote sensing data, (satellite/aerial photos, geomagnetic & gravitational data)
previous exploration and geology reports
Claim maps for the area

2) Aerial geophysics

Use airborne sensors to collect information on the geomagnetic or gravitational properties of the area.

3) Prospecting

Once a promising area has been located prospectors survey the area creating a more detailed picture of the local geology. Initially they look for surface signs of possible mineralization such as: gossans, showings of oxidized minerals, related minerals and rocks, geological features, etc…

In order to conduct sampling and exploration on the ground a claim needs to be made by map staking or ground staking in 1 to 16,16 ha units (400m x 400 m)

Sampling

Grab Samples

Grab sampling is the collection of easily accessed rock and mineral samples from exposed outcrops of rock, showings and stream beds to be assayed (tested) in a lab.

Soil samples

Samples of soil can indicate the presence of deeper minerals that may have weathered out of the deposit into the soil.

Assay

An assay is a series of tests to determine the make up and value of the samples collected from the prospect site. Samples collected at the prospect are sent to

Preliminary Exploration

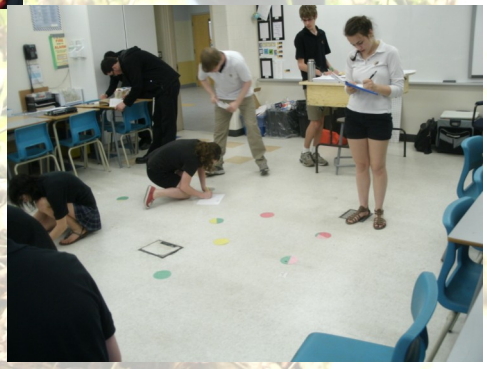
a lab to be tested. There are a number of different types of tests that can be done.

Fire Assay– is the oldest assay method, it involves grinding and then heating the samples until they melt to remove different components of the sample.

Chemical assay– a series of chemical tests to determine the components and the value of the samples collected.

Instrument Assay-A series of tests using specialized instruments to determine the components and the value of the sample collected. This can include x-ray diffraction, spectral analysis, and examination of thin section by microscopes.

Assaying determines the make up of the sample and its properties (chemistry), and value.



Ideas for Ecorporating Preliminary Exploration into Lessons

The following are ideas that you could use to incorporate Preliminary Exploration concepts into your classroom lessons.

1) Review of existing Resources

Media Literacy (maps)

With media literacy, specifically graphic literacy introduce students to different types of maps including geology maps, surficial geology or claim maps. Using remote sensing images and maps works well with these graphic literacy lessons.

Landform Regions

When discussing landforms, landform regions use a geology map or remote images such as satellite or even Google Earth, to show of the landform to the surface features.

Settlement Patterns

In social sciences when discussing settlement patterns, use claim maps for the areas discussed as they very clearly show the survey lines for those locations.

2) Aerial geophysics

Science-magnetisim

A) Compass work-teach your students to use a map and compass

B) Create a model of a surface with a “magnetic” ore hidden under the surface, have students search for it using a simple compass, a compass array or a magnet on a string. The model does not need to be elaborate. A blanket, towel or other flexible material could be draped over a selection of items to create an irregular surface.

3) Prospecting

HPE

A) Land claim walk- Take your students for a walk to simulate the size of a unit land claim. 400m x400m, or multiple unit land claim.

B) Land claim rush– divide the school yard into a grid of pylons to represent the corner posts of claim. Students give each student 4 cards labeled 1-4. They need to attach the cards to the posts in the correct

Ideas for Ecorporating Preliminary Exploration into Lessons

order NE, SE, SW,NW and write down their information on it. Have it as a race, or relay where teams each take turns marking the posts but they all have to start at post one and walk/run the entire perimeter to finish.

C) Panning Relay– Have a tub of water with light sediments in it and some small dense objects they need to find. Students race to the bin pick up a pan of sediment and swirl it until they find one of the target objects. They race back and tag the next person. Use a rubbermaid tub to hold the water and sediment and low wide plastic bowls or actual gold pans to pan.

Science/math – classifying/counting

A) classify a collection of rocks by type

B) Classify a mixture of rocks and minerals into rocks and minerals

C) Count the number of different layers in the rock.

Science– Rocks and minerals

A) identify rocks and minerals using their properties.

Science-Chemistry/Properties of matter

A) Use minerals /rocks to examine and determine different properties of matter.

B) mineral testing– use the basic mineral tests to determine which sample has a particular set of materials or properties.

C) Chemical naming (HS) use mineral names to introduce chemicals then have them determine the chemical name after you give the formula or vice versa.

D) (HS) when discussing chemicals have a sample of a mineral that is a source for that chemical.

E) (HS) hypothesis the possible properties of a mineral based on its chemistry then check using testing.

F) Using a set of properties determine which sample would best suit the listed

Ideas for Ecorporating Preliminary Exploration into Lessons

properties by using tests and then determine the identity of the sample.

G) Collect soil samples and anaylse the soil samples for ions, N-P-K, etc...

Science-Optics

A) Investigating the composition of rock by examining thin sections of rock using a microscope. If you have access use polarizing lens, use them to examine the bifringement of some of the minerals.

B) determine the index of refraction of minerals using submersion in liquids of different indicies of refraction.

C) Investigate minerals that fluoresce under UV light.

Social Studies

A) Map and Compass walk - set out four posts or pylons in a square students need to determine the direction form one to the next, and mark it on a map or aerial photo of the area.

B) Set up four pylons/posts to simulate the claim posts and have students use GPS to determine the co-ordinates.

Sampling
Math-data management

A) use a large number of tokens some of which are marked to represent a desired ore. Scatter the tokens randomly on desks around the class. Each desk is a land claim. Have students record the amount of ore tokens showing on each claim without touching any of the tokens. Have students then randomly sample each claim by turning over a set number of tokens. Again recording the number of marked tokens shown. Have students make an educated guess as to which claim will yield the most ore.

Advanced Exploration

Land purchase
In-depth geophysics studies
In-depth geological studies
In-depth geochemical studies
Environmental studies
Preliminary Closure
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Land Purchase

If the prospects are good for further detailed and more invasive tests land is often purchased to enable easier access and more in-depth and invasive exploration techniques

In-depth Geophysics Studies

A variety of geophysical studies can be completed to develop an understanding of what is under the surface.

Magnetics

A closer more detailed magnetic anomaly survey is often done from the ground by moving magnometers in a grid pattern over the site to determine a more accurate map of the magnetic properties of the ground.

Resistivity

Electrodes are inserted into the ground to generate a current. Probes are inserted through out the area to get an understanding of the electrical resistance offered by the subsurface materials.

Induced Polarization

Often used in conjunction with resistivity measurements is measuring induced polarization. When the current flows through some anomalies absorb the charge. When the inducing charge is turned off, these bodies then slowly release the built up charge. Induced Polarization surveys look for the slow drop off current due to these anomalies.

Seismic studies

Prospectors use geophones spread out over an area, then create a seismic wave, with a small explosive, or a large weight dropped onto the ground. The geophones record the waves as they arrive. The patterns of seismic waves reflecting and refracting can help determine the presence of anomalies.

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Radiometric

Radiometric surveys are often used when the anomaly that is sought is radioactive, or related to a radioactive source. Sensitive Geiger counters are used to search for the emerging radiation.

In-depth geological studies

A variety of tests can be carried out examining the bedrock and geologic features. Trenches can be dug in the overburden to expose the bedrock. After washing the exposed rock samples can be chipped out of the bedrock. If a very promising feature is located a channel sample can be taken but cutting a 10cm wide by 2 cm deep channel out of the bedrock across the anomalous feature.

In-depth geochemical studies

An increasing volume of samples needs to be collected and then tested as the exploration continues. The data from all of the samples needs to be compiled, and analysed in the context of the geologic setting of the prospect to try and identify 1^{ry} Ore formations and 2^{ndry} Ore Formations.

Environmental studies

Exploration and mining is ultimately invasive to the environment. If the prospect were to continue a base line environmental understanding for the location needs to be completed to determine the possible impacts to the environment. These studies develop an understanding for the sites' needs for monitoring and to assist with the closure plans.

Preliminary Closure

Of 5000 prospects, 500 may go on to evaluation and only 1 may become a mine. In the process of exploration, alteration to the land in inevitable. Plans need to be made to repair and return the site to its former state or a safe useable state for society, regardless of if the prospect can be come a mine or not.

Drilling

Drilling is an expensive undertaking, but is important to get a clear sample of what is under the ground.

The variety of drilling options is increasing rapidly, from drill diameter, (A 27mm, B 36.5mm, N 47.6mm and H 63.5mm) to drill heads, shaft types, drill portability and power, even the ability to steer a drill bit underground increasing the ability to develop an understanding of what is in the ground.

Wireline Drilling

Wireline drilling is where a circular drill bit tipped with diamonds is used to drill

Advanced Exploration

out a cylinder of rock from the ground. A wire drops down into the drill bit to periodically retrieve the cylinder of rock. The rock cylinder is called a drill core sample. This sample is cross sectional sample of the rock. It can be then studied and analysed to determine the depth and location of features, rock and ore.

Reverse Circulation drilling

Reverse circulation drilling also brings samples to the surface to be analysed, but they are brought up as pulverized rock and chips. They are brought to the surface by a circulating drilling fluid that is pumped down the hole to lubricate the drill head and push the samples to the surface through the hollow drill tube.

Road Building

As the exploration phase progresses, more equipment needs to access the site. Roads and other avenues of access are needed to allow for the needed access to the site.

Ideas for Ecorporating Advanced Exploration into Lessons

The following are ideas that you could use to incorporate Advanced Exploration concepts into your classroom lessons.

1) Geophysical studies

Science– mechanics

A) Have the students build devices that can record the movement of the ground (seismometer) Place the devices around the class room and drop a weight on the floor and observe how well their devices work. Can also be used with earth quakes.

B) Repeat the above using the accelerometers in tablets and smartphones. There are many free seismometer apps that work well.

Science– electricity

A) create a model using different clays and doughs to create a landscape. To some of the doughs add extra water and different salts, to others use de-ionized water and no salt to others add iron filings, or other modifications to vary their conductivity. Have the students use a simple circuit of a battery an ammeter and volt meter attached to two metal probes. Students draw a map of the landscape. They then attempt to find the portion of the landscape with the lowest resistance, by inserting the two probes into the landscape and calculating the resistance using Ohms law. Repeat many times in many locations.

2) Drilling-Core

Math-data management

A) Students measure and create a graph showing the depth of each layer of rock

B) students measure and create a broken line graph for the depth of a particular layer in a series of drill cores (Simulated)

C) Determine the volume of a jelly donut with out eating or cutting it. Use large diameter straws to take core samples of the thickness of the dough layers and determine the dimensions of the jelly cavern.

Math-estimation

A) Core thickness– have students use a drill core (real or simulated) for estimation practice. Questions could include the thickest/thinnest layers, the thickness of each layer, total length, how much is a particular rock or rock type, etc..

Ideas for Ecorporating Advanced Exploration into Lessons

Math-measurement/geometry

A) Core thickness-have students use a drill core (real or simulated) to practice making measurements of layer thickness.

B) Students measure then determine the volume of the core that is a particular rock, or rock type.

C) Encase a small hard object (shape) in a ball of playdough or plasticine. Students use a fine metal probe or bamboo skewer to push into the ball in many different sports to determine the dimensions of the inner object.

Math-proportional reasoning, scale

A) students create a scale diagram of a drill core (real or simulated)

B) Students create a scale diagram of the cross section of a rock body taken using a series of simulated drill cores.

Math– linear equations and relations

A) Students measure the depth of different layers in two adjacent drill cores (simulated) then calculate the slope between the adjacent layers.

B) Students measure the depth of different layers in two adjacent drill cores (simulated) then determine an equation to represent the contact line between the two adjacent cores for each layer.

C) Students measure the depth of a distinct layer in two adjacent drill cores (simulated) then determine a linear equation to model the layer as suggested by the drill cores. Students are supplied with a linear equation to model the path an angled drill core will take. Students predict where the new core will intersect with the tracked layer.

Math-quadratic equations

A) students measure the depths of the layers for three adjacent drill cores (simulated). Students then use the depth values and the distance from each core to develop a quadratic model to illustrate the layers from one core to the next.

Ideas for Ecorporating Advanced Exploration into Lessons

Science-Earth Science

A) Simulate many of the tasks of exploration.

B) Students could measure and create a cross-sectional fence diagram of the rock underground using adjacent drill cores (simulated). Students would need to identify each layer and trace each layer to determine possible features and relative history from the rock strata.

3) Environmental Studies
Science-Ecology

A) students act as a governmental regulatory body to set guidelines/restrictions for exploration work to minimise impact to the environment. Students would need to identify possible concerns and determine a method to mitigate each concern.

B) students could act as the exploration company and develop a plan to collect samples and data while minimizing impact to the local environment.

C) Have the students conduct an environmental assessment of the school grounds but collecting soil, water, population counts using quadrant sampling, etc...

The Mining Cycle

Exploration

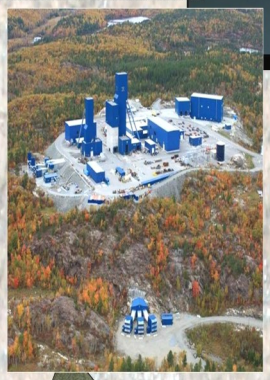
The first stage in the mining cycle is the exploration phase.

Evaluation

The second stage in the mining cycle is the evaluation phase.

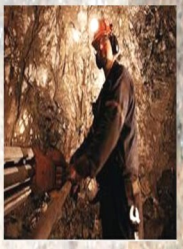
Development

The third stage in the mining cycle is the development phase.



Production

The fourth stage in the mining cycle is the production phase.



Closure

The fifth stage in the mining cycle is the closure phase.