

What are rare earth elements?

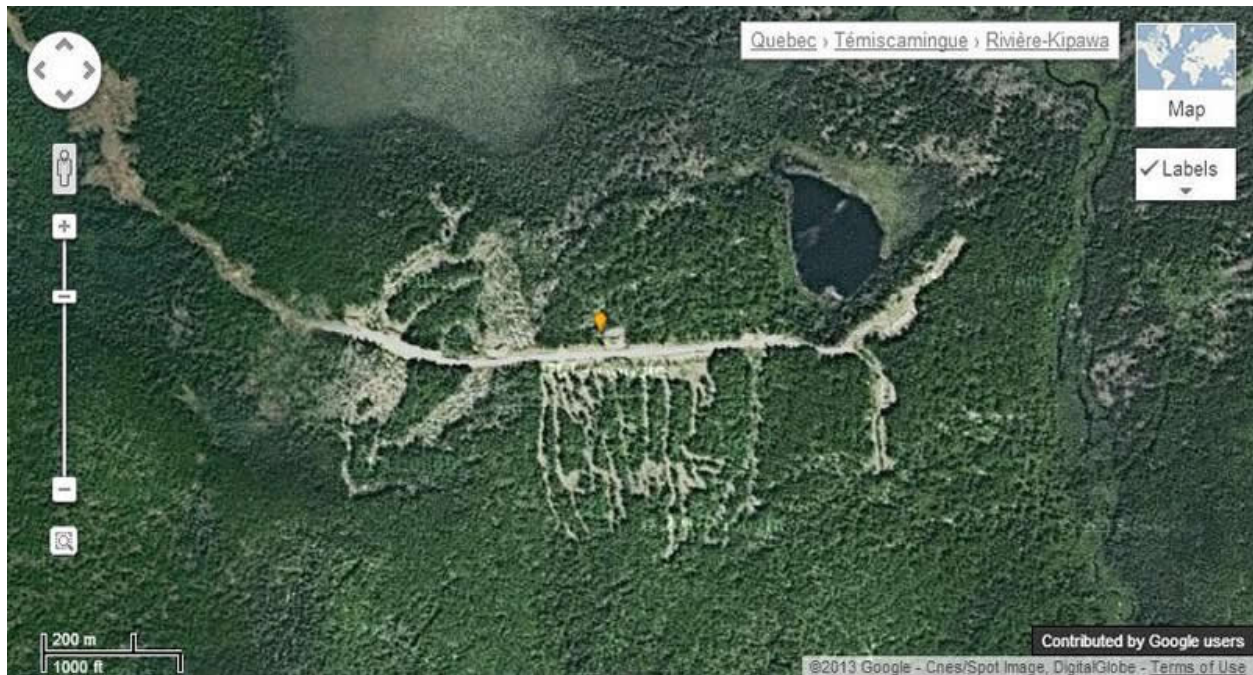
- 16 elements on the periodic table
- Not actually rare
- Used in magnets, batteries, electronics, magnets, lasers, hybrid cars, motors, LCD screens, oil refining, weapons of defense, etc.
- Most uses are not 'green'
- Mining rare earths releases many air pollutants including: nitrogen dioxide, sulphur dioxide, carbon monoxide, particulate matter and dust fall.
- Greenhouse gases such as carbon dioxide, methane and nitrous oxide are also released
- Many companies market rare earth mining operations as 'green' as the intended use of some of the ores are in products designed to lower carbon emissions. Procedures used to obtain rare earths are very damaging to the environment and far from being 'green'.
- Historically rare earth supply worldwide largely from China

"According to the Chinese Society of Rare Earths every ton of rare earth elements produced generates 8.5 kg fluorine, 13 kg flue dust...9,600-12,000 cubic meters of gas (laden with flue dust concentrate, hydrofluoric acid, sulfur dioxide and sulfuric acid)...75 cubic meters of acidic waste water and one ton of radioactive waste residue" US EPA 2011

- The processing of rare earth ores is frequently done on site and requires strong acids and bases (most often sulfuric acid, hydrochloric acid and lime). These chemicals must be transported to the mine site putting other areas at risk should spillage occur.
- Wastes produced must be properly managed to prevent their entrance into the surrounding environment.
- Rare earth mining is a new industry in Canada with only one mine (Nechalacho in NWT) that has just commenced production, but there have been environmental disasters associated with rare earth mines in other developed nations.
- Mountain Pass rare earth mine in California was shut down in 2002 in part due to environmental concerns. During its operation the mine released over 600,000 gallons of waste water containing thorium into the nearby desert ecosystem. Local groundwater has been contaminated with radium, thorium and strontium.
- The Kerr-McGee company had 4 rare earth sites in the state of Illinois. These sites are now among the most contaminated sites in all of the United States.

Mining Exploration

- Exploration can include surveys, field studies, drill test bore holes, air-borne magnetic, radiometric and gravity surveys
- The exploration phase may also involve clearing of large areas of vegetation, usually in lines to allow entry of drilling rigs
- Many countries require an environmental impact assessment (EIA) to be done prior to the start of exploration. In Canada exploration can be carried out without an EIA and even without a prospector's license. However, a prospector's license is required to develop a property into a mine.



Aerial view of Matamec's exploration and site for the proposed Kipawa Rare Earths project. Exploration carried out to date includes 293 drill holes and 13 trenches.

Development

- This phase involves the construction of access roads, which can have substantial environmental impacts.
- Site preparation and clearing may involve the clear-cutting and/or burning of vegetation.
- Dump trucks, bull-dozers and other heavy machinery are often used to removed soil and expose bedrock.
- Open pit mining involves the use of explosives to remove ore. This blasting creates a great deal of dust causing negative effects on air quality. Blasting can also be harmful to fish, aquatic organisms and other wildlife.
- Ores are extracted from deep underground. The resulting pit is often below the water table and will continuously fill with water (both from groundwater and precipitation). After mining operations cease a pit lake usually forms.

Waste Rock

- Large quantities of waste rock are produced. The waste rock usually contains high levels of toxic and radioactive substances. The rock is normally left on site in large piles.

Ore Extraction

- Using heavy machinery the ore is extracted and transported to processing facilities. This process releases harmful dust and impacts air quality.

Ore Processing

- Ores extracted must be processed to refine and obtain the element or metal of interest.
- Methods used to process the ore may include physical and chemical processes such as magnetic separation or chemical separation (leaching). Both methods are used in the

processing of rare earth ores. Chemical separation requires the use of large quantities of strong acids and bases (usually sulphuric acid, hydrochloric acid and lime).

- The processing generates large quantities of toxic and often radioactive wastes called 'tailings'
- Tailings are often stored on-site in tailing ponds for eternity.
- While measures can be taken to prevent their release into the environment, such as the use of a geomembrane and tailings dams, these structures often have lifespans that are a great deal shorter than that of the toxic and radioactive substances that they are meant to contain.

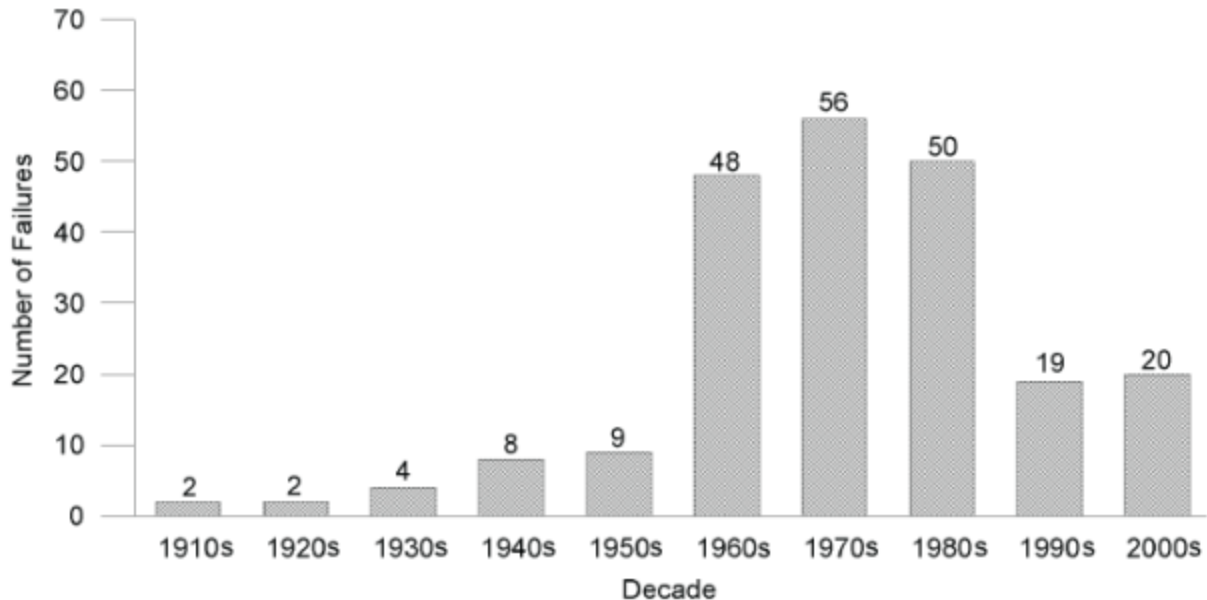


Figure 1. Failure events over time.

The figure above shows the number of tailings dam failures over time.

- Unfortunately, tailings dam failures have increased in recent years with multiple failures abroad and in 2014 the Mount Polley Mine in BC had its tailings dam fail sending 24 million cubic meters of mine waste into Haseltine Creek and Quesnel Lake.

Geomembranes

- The performance of a geomembrane is dependent upon many factors including temperature, exposure to UV-light, exposure to radioactive substances, as well as the materials used to fabricate the membrane and its thickness.
- HDPE and LLDPE geomembranes with 1.5mm to 2.0 mm thicknesses are commonly used for tailings ponds. These geomembranes can have average lifespans as low as 36 years while the radioactivity of the materials they contain will persist for thousands of years. They may be sufficient to protect the current generation but not future generations.
- Geomembranes can be damaged or punctured due to high loads, seismic activity, deformation of pipes connected to the drainage system. Geoelectric leak technology can be used to detect leaks in geomembranes but the mining industry has been resistant to its use despite the fact that it is economically feasible and helps reduce environmental risks.

- Contrary to what many believe geomembranes are not completely impermeable. They do have leakage rates which are dependent upon many factors as described in the table below

head (m)	LEAKAGE RATES (liters/hectare/day)			
	geomembrane high quality	geomembrane average quality	geomembrane low quality	clay only (1m)
1	6	37	79	864
5	35	208	446	4,320
10	86	503	1,077	8,640
20	230	1,350	2,894	17,280

- Once a mining company has closed its operations it is often up to the taxpayers of the region to manage the waste. This can be quite costly should an accident occur. In Kootenay B.C. the dam on a decommissioned tailings pond containing heavy metals began to give way, repairs cost over \$500,000.

<http://www.cbc.ca/news/canada/british-columbia/story/2012/08/03/bc-tailings-pond-kootenay.html>

Please note: Information above is general information about mining and is not specific to any proposed project in the Kipawa watershed. All information provided is factual from written references provided below. The Kipawa Lake Preservation Society and its members cannot be held liable for the information provided within.

To learn more about the mining process, tailings ponds, dams and geomembranes the following are useful resources

Open Pit Mining

<http://www.abs.gov.au/ausstats/abs@.nsf/90a12181d877a6a6ca2568b5007b861c/ce28d7f5faa308ca256cae0015da32!OpenDocument>

Canadian Mining Regulations

<https://www.nrcan.gc.ca/science-data/science-research/earth-sciences/earth-sciences-resources/earth-sciences-federal-programs/legislation-and-regulations-mining/8692>

Quebec Mining Regulations

<https://www.legisquebec.gouv.qc.ca/en/document/cs/m-13.1>

Tailings Dam Failures

<https://www.wise-uranium.org/mdaf.html>

Geomembrane Lifetime Predictions

<http://www.geosynthetic-institute.org/papers/paper6.pdf>

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