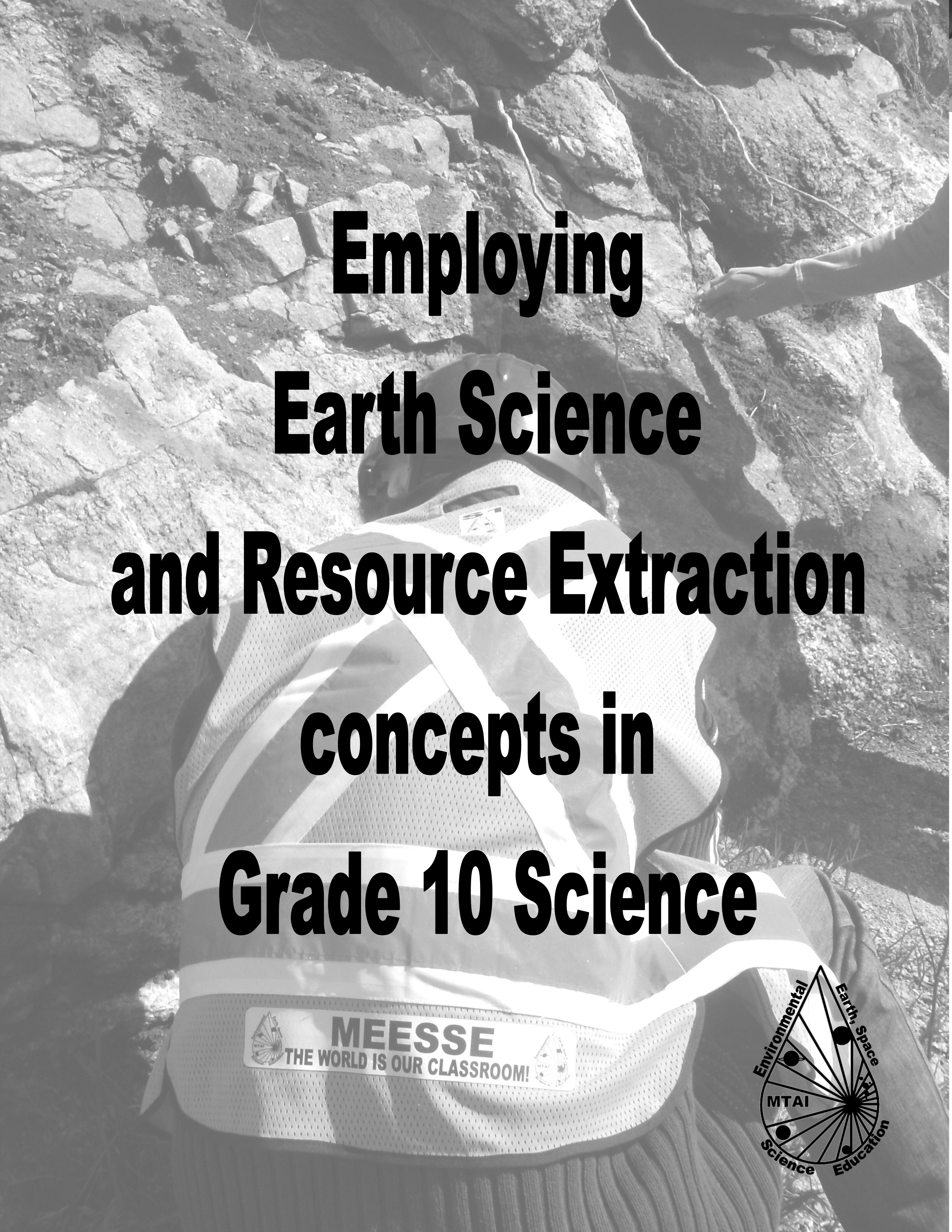
Employing Earth Science and Resource Extraction concepts in Grade 10 Science



Environmental Earth, Space Science Education
MTAI

Introduction

The Earth is our one and only home. Over my teaching career, I have noticed the number of students who have an appreciation and knowledge about our dependence on the Earth has been declining. Few students know where their stuff comes from other than maybe the country it was assembled in, or the store it was purchased at. I have spent the last several years trying to increase the students at my school's awareness of the Earth and it importance to us. My original goal was to introduce the grade12 Earth and space course (SES 4U) to my school. In my journey to increase awareness, I looked for opportunities to incorporate Earth Science topics into every course that I taught. This guide is one of the by products of my efforts.

The intent of this guide is not to be a lesson plan document, dictating in teacher speak what should be done and when. I find many of those type of documents lean very heavily to one teaching style or another and can be time consuming to comb through and require significant alteration to modify for your own teaching style. My intent is to share many of the ideas that I have used to tease out Earth science applications into my teaching with limited additional fluff. Use what you want, take and build on my ideas to suit your classes and teaching style.

This guide was written targeting Ontario's Grade 10 Academic Science SNC 2D course. I targeted SNC 2D for two reasons. The first is time commitment. SNC2D is the course that I teach most frequently. The second reason is that this course is the prerequisite for Ontario's Grade 12 Earth and Space Science course (SES 4U). Although written to target this course, many ideas and activities I have used in it are appropriate for many other grades and disciplines. In fact, many activities are modified from activities taken from early elementary, some directly and some with a slight spin.

This current printing is a work in progress, even at the time of printing, I am developing further lessons to fit this course.

If you have any comments, or would like additional information on this or any work I have done, please contact me at millardndchs@gmail.com.

Rob Millard
Dec ember 2013

Chemistry Activity Overview

The grade 10 chemistry unit offers a number of opportunities to incorporate Earth Science examples and topics into the delivery of a program.

Properties of Matter Review

In grade 10 reviewing the concepts of properties of matter, focusing on the distinction between a physical property and a chemical property is often a common starting point. There are several activities that I use, that I have included.

The first is a group information scavenger hunt, where each student receives a list of information that they need to find from their fellow class mates. It gets them up and involved with each other and has a distinctive mineralogical spin to it.

Previously in grade 9 science classes the topic of physical and chemical change require more time, and lend themselves well to the use of the mineral tests often used in grade 4 and those in the Mining Matters-Deeper and Deeper junior kit and Earth's Crust II intermediate kit.. Students can develop a great amount of information quickly about different properties that a sample may have. The activities are much easier to introduce, yet just as difficult to get them to want to stop, especially with the chemical testing being done by the student instead of a teacher demonstration. In grade 10, I often revisit these activities. I will give each student a different sample and have them collect as much data about its properties as possible in a given time. After the given time, they then try to match the data they collected with a list of properties to determine the chemical formula, and mineral name of the sample. They then try to suggest potential uses and uses to avoid based on the properties they collected.

Chemical versus Physical Change

Getting the students to identify physical and chemical change I often employ a number of demonstrations done one after the other of some form of change. Students take notes of the material pre and post change and then determine if each was a physical or chemical change. I include a number of activities that have some link to the Earth sciences. I have only included a brief description of some of the demonstrations I have used over the years.

Naming of Compounds

Many minerals are ionic compounds that can be used when introducing and practicing naming ionic compounds. The minerals can be introduced in a wide variety of formats from the use in practice questions, worksheets, or in conjunction with actual samples of the minerals. If you are using samples of minerals to aid the delivery of content, remember that they are chemicals and many do have safety concerns regarding safe handling and storage. Included in this guide are several pages that can be used for reference or as a worksheet for student practice. Ionic Naming 1, deals with basic ionic naming of metal and non-metals. Ionic Naming 2 and 3, are minerals where the students also need to determine the cation charge used for the IUPACC naming. Polyatomic Ionic Naming 1 and 2, contain examples where polyatomic ions are used. There is one polyatomic ion that crops up in the examples that does not show up in most science texts, it is the silicate ion $(SiO_4)^{-4}$ This is a very important polyatomic ion to add to the class if you are trying to incorporate Earth Science topics into the unit, as minerals are often classified as silicate minerals or not.

Balancing Equations

Often when presenting balancing equations in class, students are simply given a list of many reactions that they need to run through the process of balancing. Presented in this manner, students often loose sight of the connection to chemistry. By presenting the equations they are to balance with a bit of background on what the reaction is and where it can be found, gives deeper meaning and continues to encourage students to look for the link of chemistry. There are many chemical reactions that occur in the Earth Sciences. Using some of these reactions as example reactions that students can use to balance, is a good exposure to some of the processes of Earth Science. In this guide are several pages of equations that students can use to practice balancing equations with the context of where the reactions could be found.

Reactions

Many of the reactions that occur in Earth science are slow reactions that develop over long periods of time, or in environments that are difficult to simulate in a high school lab. There are few reactions that can easily be explored in a high school classroom. Included are examples of copper leaching, lime production, Acid Rock Drainage, and acid precipitation investigations. These can be worked as either a demonstration or a lab.

Acid Base– Case Study

At this time, this is a work in progress, but the idea of a case study on the impacts of acidic gases, and acid precipitation on the environment using the history and the re-greening of Sudbury, ON.

Field Trip/Excursion Ideas

Included are a few suggestions of possible field trip or excursion ideas incorporating earth science themes and chemistry

A mineral dealer is going to ship a number of minerals. Prior to shipping each mineral sample needs a chemical names for the WHMISS label. Determine the chemical name for the following minerals:

Baddeleyite	ZrO_2
Carobbiite	KF
Chlorargyrite	$AgCl$
Chloromagnesite	$MgCl_2$
Cinnabar	HgS
Corundum	Al_2O_3
Fluorite	CaF_2
Frankdicksonite	BaF_2
Griceite	LiF
Halite	$NaCl$
Lime	CaO
Matraite	ZnS
Molybdite	MoO_3
Montepointe	CdO
Periclase	MgO

Convert the following reactions to skeleton equations:

Chalcopyrite is an copper ore. To remove the copper the ore concentrate is heated to between 500^{o}C and 700^{o}C a reactions creates :

Iron(II)oxide + Copper(I)sulfide + Sulfur dioxide

The Copper is then further separated by a reduction reaction:

Copper(ii)Sulfide + oxygen ➔ copper + sulfur dioxide

Iron is often separated from its ore by chemical reactions in blast furnaces at temperatures well over 1000^{o}C. Iron is less reactive than Carbon so, in a reaction carbon will replace Iron. A series of reactions occur to free the iron from the host minerals. The process starting with burning coke (Coal-C) in the presence of iron ores in a blast furnace, to generate the temperatures needed and the reactants.

Carbon+ Oxygen➔ Carbon dioxide

Carbon dioxide +Carbon ➔ Carbon monoxide

(hematite Ore)

Iron(III)oxide+carbon monoxide➔Iron+ Carbon dioxide

(Magnetite Ore)

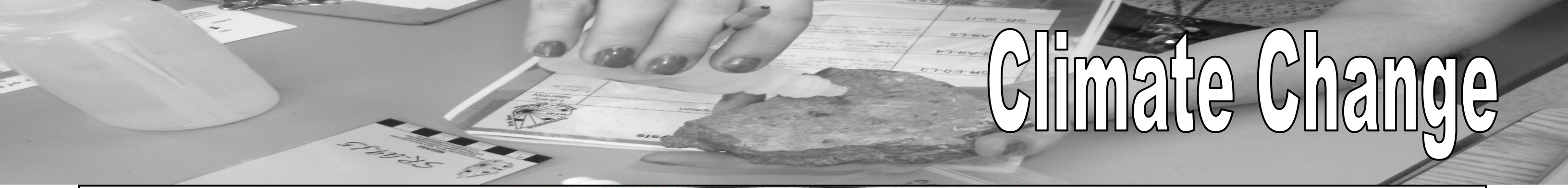
Fe_3O_4 + Carbon monoxide ➔ Iron + Carbon dioxide

Aluminum is different it is more reactive than carbon and requires a different process known as electroplating. This requires huge amounts of electricity to run through a vast containing Bauxite (Al ore) the electricity beaks the ionic bond pulling the aluminum cation to the cathode (-terminal) and the oxygen to the anode (-terminal).

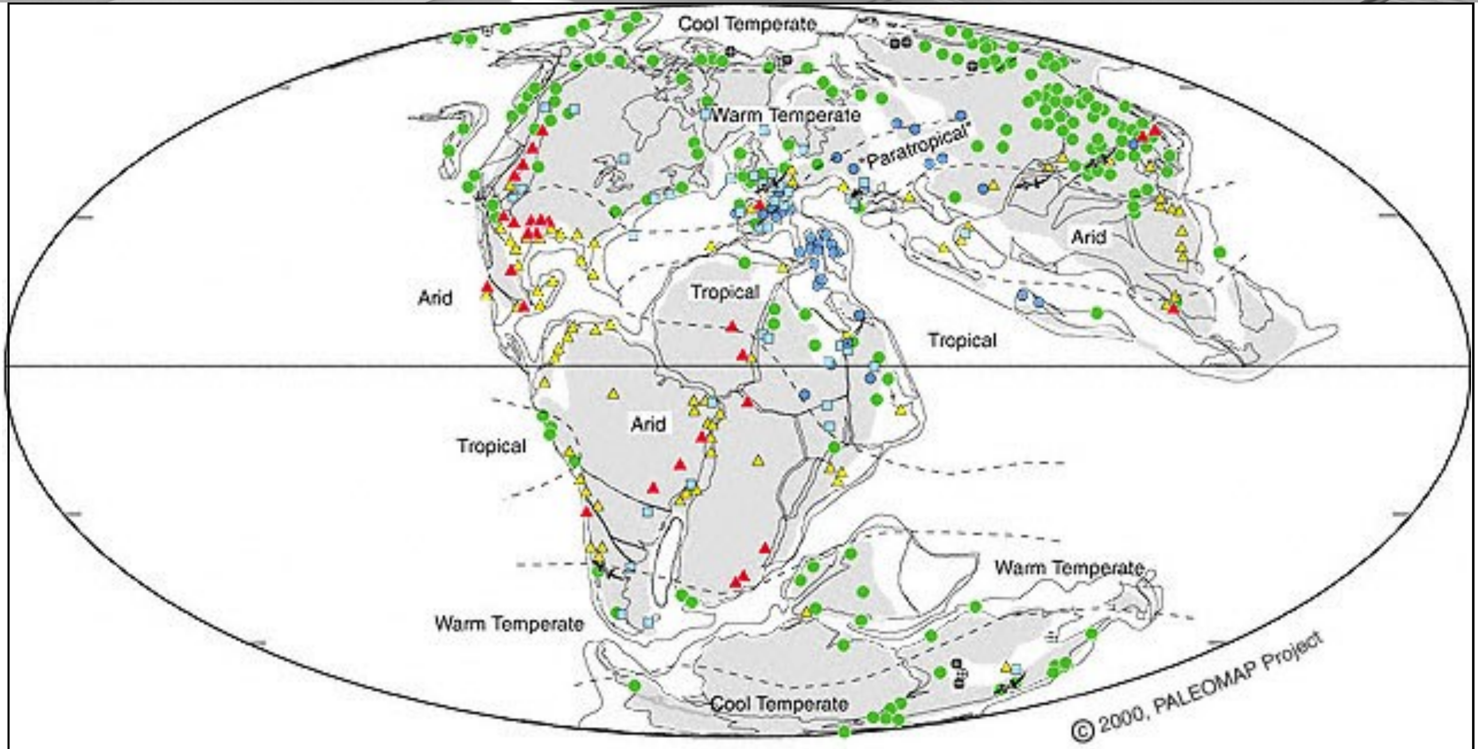
Aluminum oxide➔ Aluminum + Oxygen

The following natural reaction is one that contributes to an environmental issue known as acid rock drainage (ARD). Pyrite when exposed to the “elements” (air and water) react to form sulfuric acid when mixed when in solution with water. As a result the ground water becomes acidic altering the downstream environment.

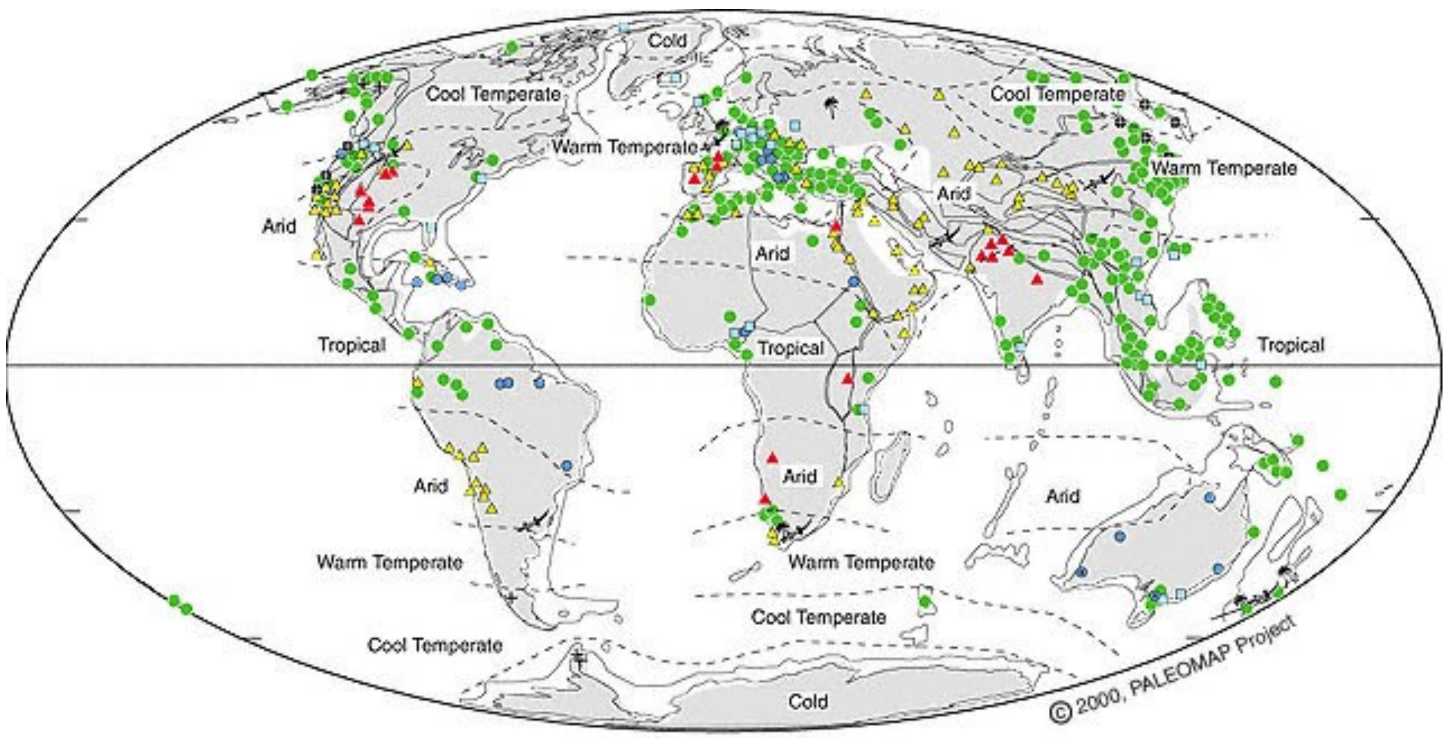
Iron(II)sulfide + Oxygen+ Water ➔ Iron(III)sulfate + Hydrogen sulfate



Climate Change

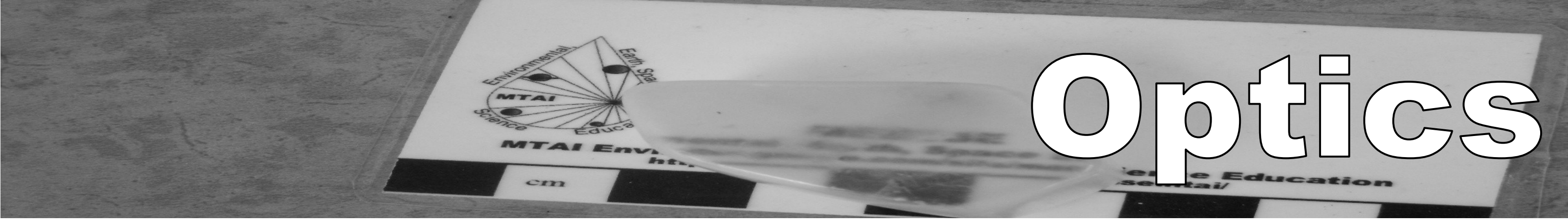


Lower Cretaceous



Miocene

How would the likely Ocean currents effect the distribution of heat on the planet?
What other climate effects would likely have been effected?



Index of Refraction

Snell's law:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

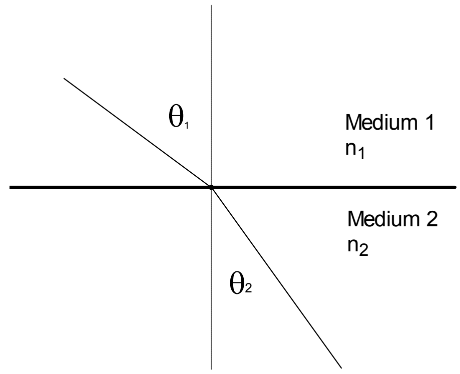
Speed of light:

$$n = \frac{c}{v}$$

Index of refraction various media.

Air=1
Ruby =1.757
Sapphire =1.779
Zircon = 1.987
Zirconia, Cubic =2.173
Diamond = 2.417

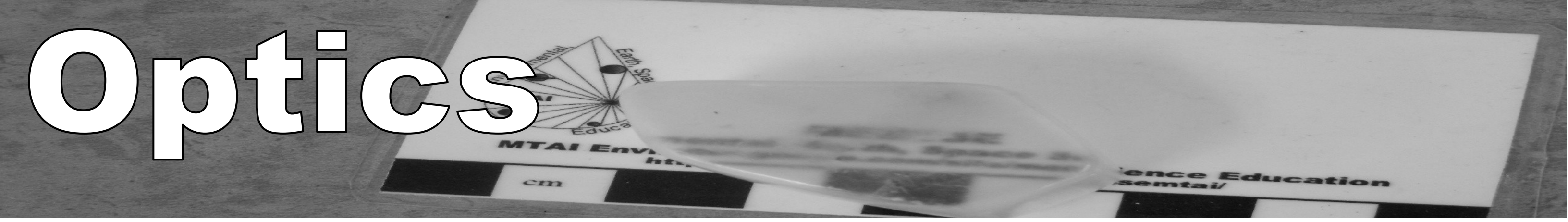
Calcite =1.486
Obsidian =1.50
Quartz =1.553
Halite= 1.544
Emerald =1.560
Tourmaline= 1.603
Topaz=1.607



Determine if the ray will bend towards or away from the normal for the following:

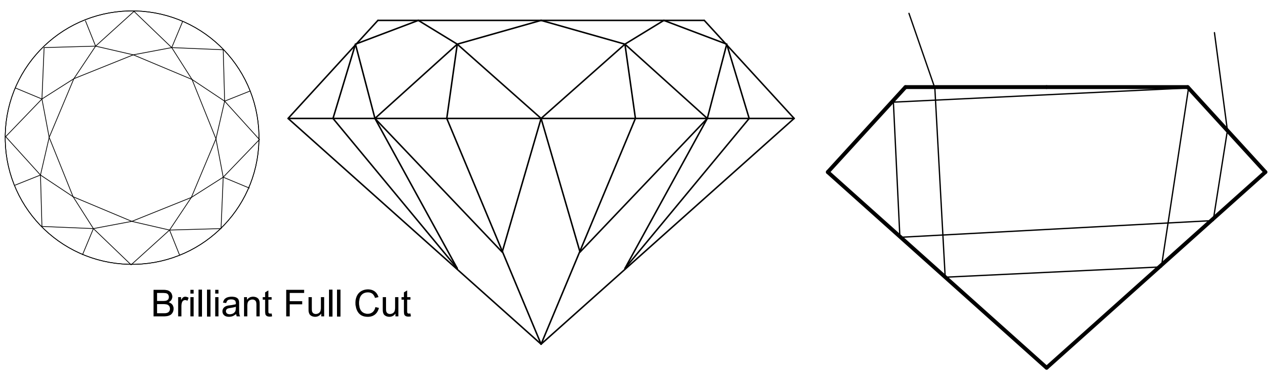
From	To	
Air	Ruby	
Diamond	Cubic Zirconia	
Zircon	Cubic zirconia	
Calcite	Quartz	
Topaz	Air	
Air	Topaz	
Halite	Air	
Halite	Sapphire	
Diamond	Tourmaline	
Sapphire	Air	
Ruby	Air	
Ruby	Sapphire	
Emerald	Halite	
Quartz	Emerald	
Zircon	Tourmaline	
Air	Calcite	
Quartz	Calcite	

Optics

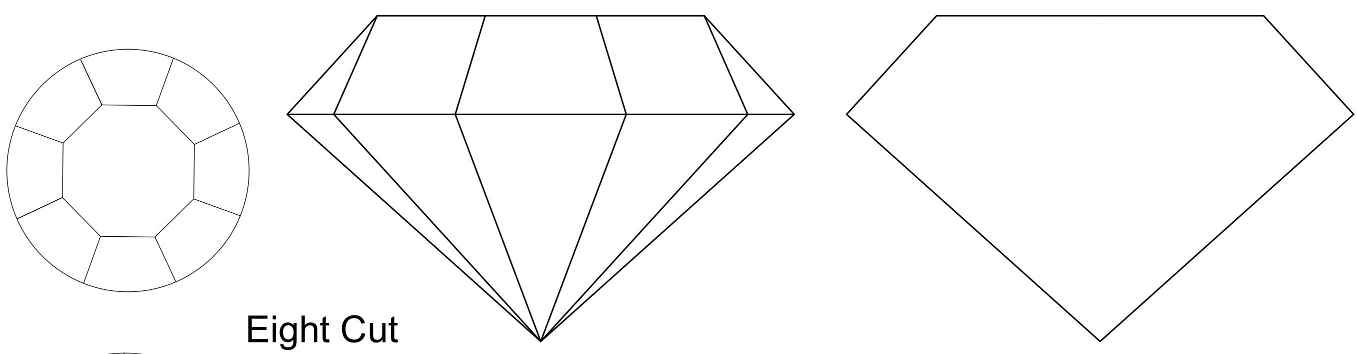


Gemstone Cuts

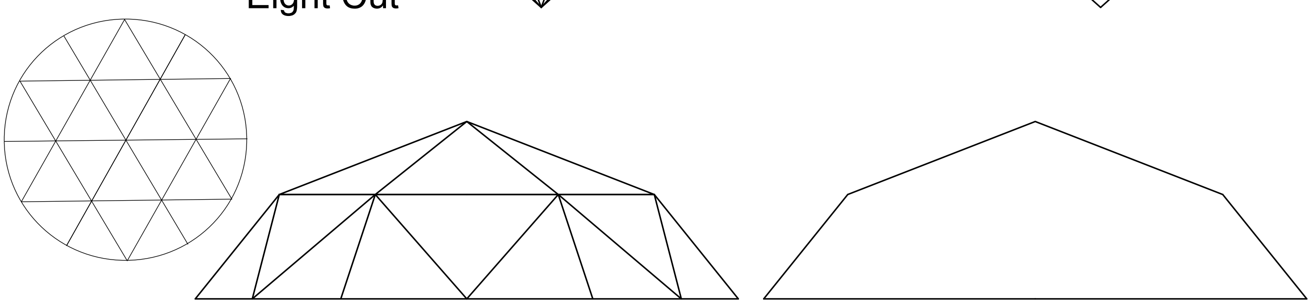
Some minerals are cut and polished into gemstones. The following are examples of different ways of cutting a mineral to make a gemstone. Draw the path of a ray of light that enters on a top face. Use the critical angle for diamond to air of about 24° to determine if you ray will remain in the gem and reflect, or exit the gem and refract. The first has an example done for you.



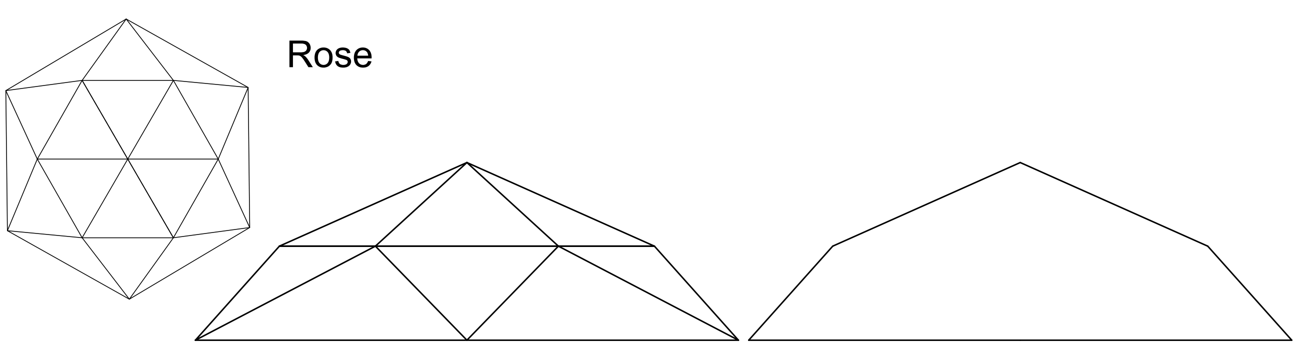
Brilliant Full Cut



Eight Cut



Rose



Half Dutch Rose