PALEONTOLOGICAL
RESEARCH INSTITUTION

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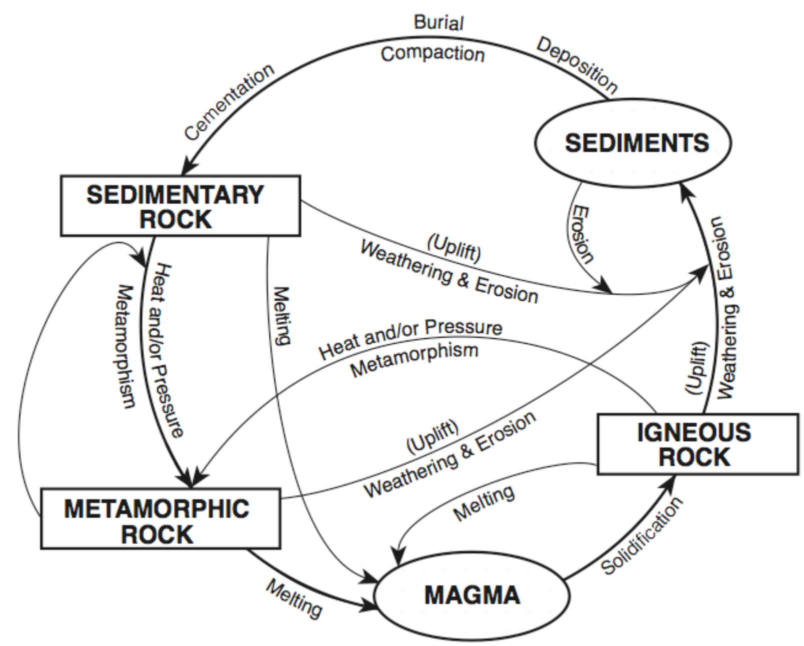
ReaL Earth Inquiry Field Notebook

Student Edition



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Summer 2009 Edition
Adapted from Earth Science Journal *by Sarah R. Miller, Deposit High School, Deposit, New York.*

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*These charts are from *Earth Science Reference Tables* (2001; 2006) The University of the State of New York • THE STATE EDUCATION DEPARTMENT • Albany, New York 12234 • www.nysed.gov

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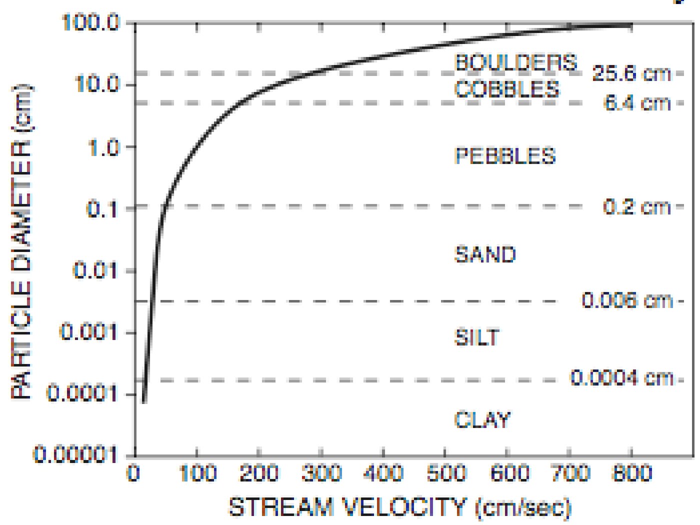
Relationship of Transported Particle Size to Water Velocity



*This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

WHY DOES THIS PLACE LOOK THE WAY IT DOES?

This question drives our work in Earth science this year. We will ask it in many different forms. For example, sometimes we'll ask about *things* instead of *places* or about the way something *sounds* instead of the way it *looks*. What we are really trying to figure out is why a place or an object is the way it is.

To figure out why something is the way it is we first need to look closely. Helping us to carefully observe is perhaps the most important purpose for this notebook.

We have a much better chance of making the world (and our own lives) better if we understand the world. Understanding requires looking closely. Of course, one person cannot look closely at everything in the world, and someone in Buffalo has a hard time looking closely at something in Oklahoma, for example.

Notebooks are tools that scientists use to help them make sense of the world. That's what we'll be using ours for too. Just owning a notebook is not really helpful – we need strategies to use it thoughtfully.

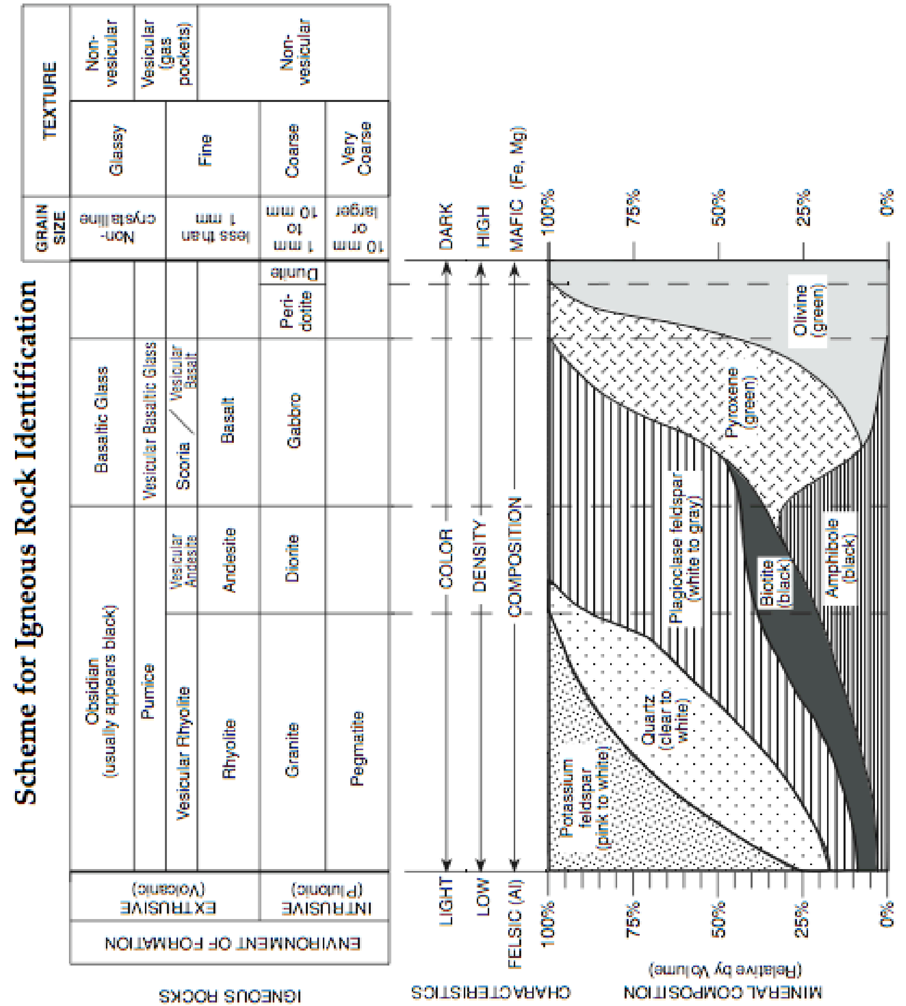
Scientists, like historians, have tools and strategies for looking closely. Those strategies include:

- **Using "The Scientific Method."** In reality, there are many, many scientific methods and while a great many discoveries are made using the important processes of careful experimentation, many more discoveries result from other methods.
- **Using the local to understand the global.** The basic processes that shape the Earth are the same in New York as in Oklahoma, England or China.

- **Taking careful notes, often including labeled drawings.** Look at your fish! In the case of fieldwork, your notes should include the exact location of your work area and as much detail as the time allows – certainly enough detail so that when you return to the location you can identify what has changed and what has stayed the same.
- **Collecting samples and/or photographs.** Most of the work we do will be in public parks where collecting samples is generally prohibited, but collecting photographs is allowed.
- **Classifying, often using keys or field guides.** The New York State Earth Science Reference Tables include keys for rock and mineral identification, for example. Those are reproduced in this notebook. Some kinds of classification are simpler – what color is it?
- **Sorting and counting.** How many different layers of rock can you see in an outcrop? How many different types of rock?
- **Measuring.** How large are the grains in a rock? What is the mass of a specimen you have collected?

This is just a starting list of strategies. We might well add others as the year progresses. You can certainly do that on your own.

What are the strategies you use to figure out the story of how something came to be the way that it is? Chances are that you do that in different ways in different parts of your life. If you are successful in making sense of things, be it basketball or baking, chances are that you are using scientific strategies. What strategies do you use?



Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	Conglomerate	
			Angular fragments	Breccia	
	Sand (0.2 to 0.006 cm)		Fine to coarse	Sandstone	
	Silt (0.006 to 0.0004 cm)		Very fine grain	Siltstone	
	Clay (less than 0.0004 cm)		Compact; may split easily	Shale	
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Crystalline	Varied	Halite	Crystals from chemical precipitates and evaporites	Rock Salt	
	Varied	Gypsum		Rock Gypsum	
	Varied	Dolomite		Dolostone	
Bioclastic	Microscopic to coarse	Calcite	Cemented shell fragments or precipitates of biologic origin	Limestone	
	Varied	Carbon	From plant remains	Coal	

Other Strategies:

MINERAL OF THE WEEK

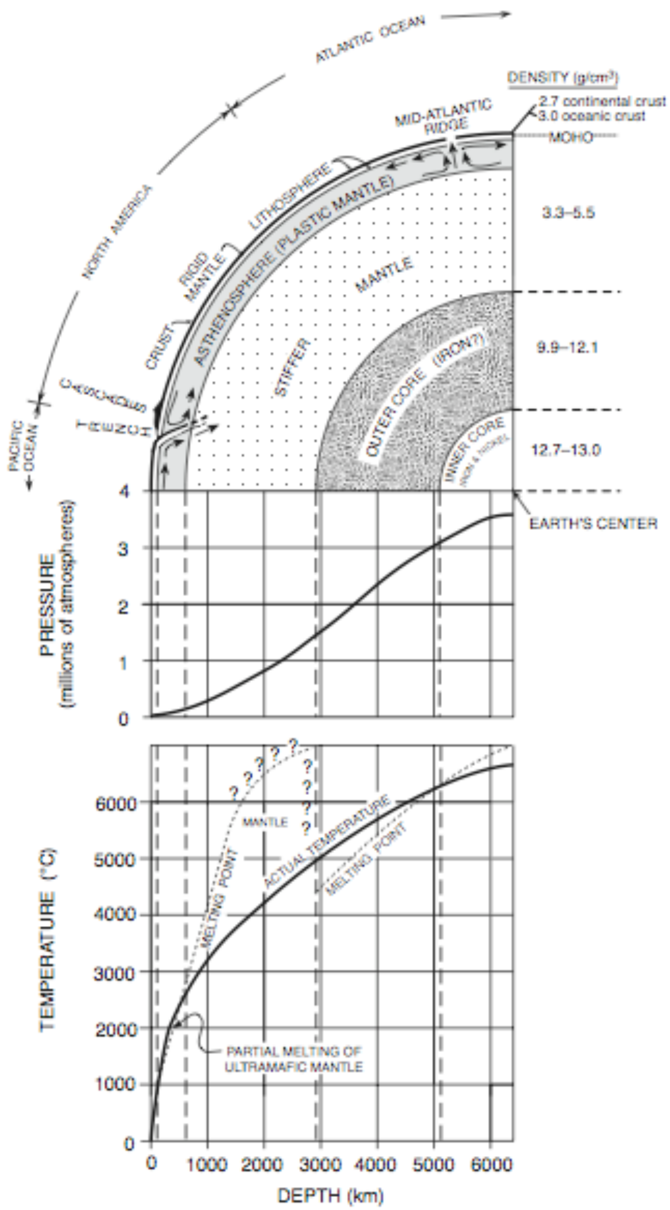
Basic Mineral Properties
Color:
Luster:
Streak:
Hardness:
Cleavage:

Date	Luster	Hardness	Cleavage

Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	Fine	MICA	Regional (Heat and pressure increase with depth)	Low-grade metamorphism of shale	Slate	
FOLIATED	MINERAL ALIGNMENT	Fine to medium	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET	Regional	Foliation surfaces shiny from microscopic mica crystals	Phyllite	
FOLIATED	MINERAL ALIGNMENT	Fine to medium	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET	Regional	Platy mica crystals visible from metamorphism of clay or feldspars	Schist	
FOLIATED	BAND-ING	Medium to coarse	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional	High-grade metamorphism; some mica changed to feldspar; segregated by mineral type into bands	Gneiss	
NONFOLIATED		Fine	Variable	Contact (Heat)	Various rocks changed by heat from nearby magma/lava	Hornfels	
NONFOLIATED		Fine to coarse	Quartz	Regional or Contact	Metamorphism of quartz sandstone	Quartzite	
NONFOLIATED		Fine to coarse	Calcite and/or dolomite	Regional or Contact	Metamorphism of limestone or dolostone	Marble	
NONFOLIATED		Coarse	Various minerals in particles and matrix	Regional or Contact	Pebbles may be distorted or stretched	Metaconglomerate	

Inferred Properties of Earth's Interior



How do I test this property?

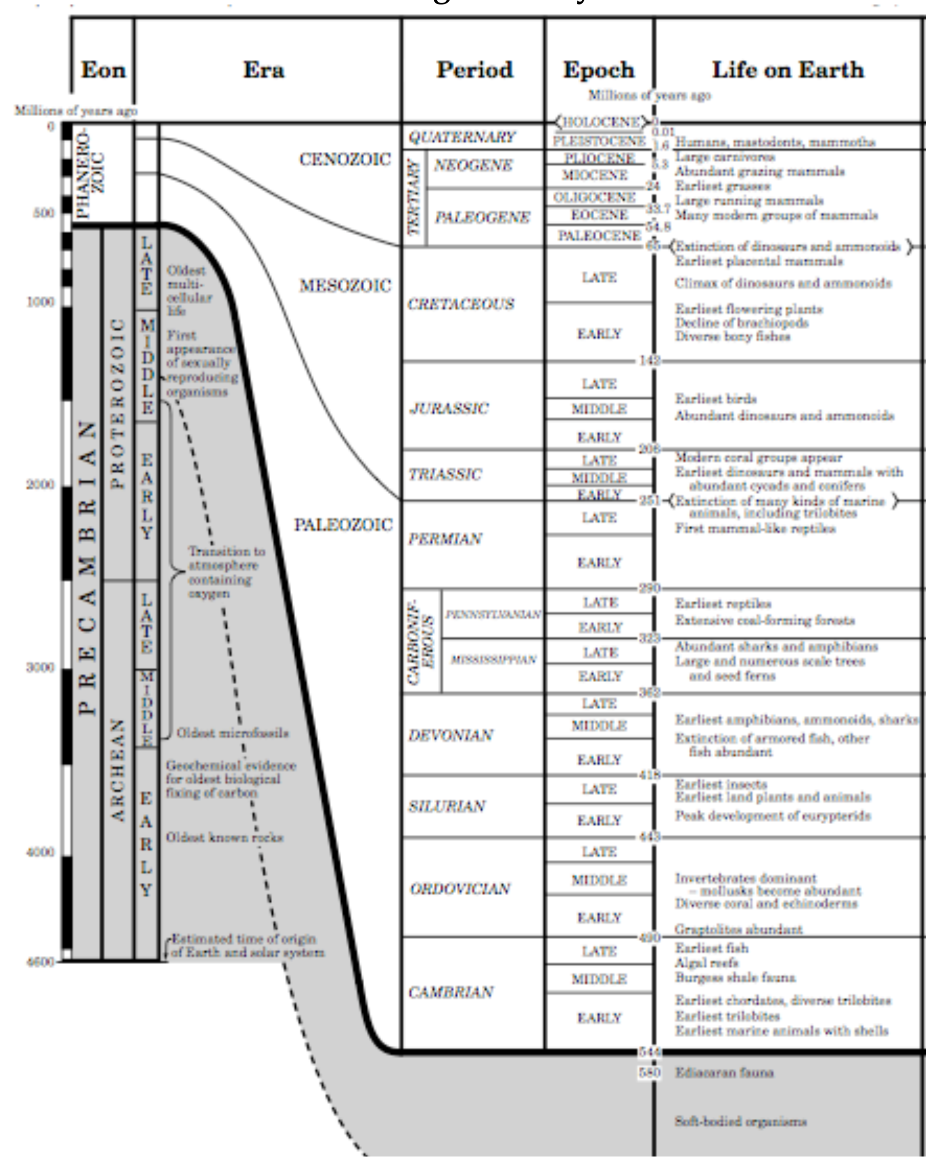
Streak	Color	Other	Mineral Name

ROCK OF THE WEEK

Rock Type	How it forms
Igneous	
Sedimentary	
Metamorphic	

Date	Rock Type	Evidence

Geologic History



Properties of Common Minerals

LUSTER	HARD-NESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	MINERAL NAME	COMPOSITION*
Metallic Luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	**Graphite**	C
Metallic Luster	2.5	✔		metallic silver	very dense (7.6 g/cm³), gray-black streak 	ore of lead	**Galena**	PbS
Metallic Luster	5.5–6.5		✔	black to silver	attracted by magnet, black streak	ore of iron	**Magnetite**	Fe_3O_4
Metallic Luster	6.5		✔	brassy yellow	green-black streak, cubic crystals 	ore of sulfur	**Pyrite**	FeS_2
Either	1–6.5		✔	metallic silver or earthy red	red-brown streak	ore of iron	**Hematite**	Fe_2O_3
Nonmetallic Luster	1	✔		white to green	greasy feel	talcum powder, soapstone	**Talc**	$Mg_3Si_4O_{10}(OH)_2$
Nonmetallic Luster	2		✔	yellow to amber	easily melted, may smell	vulcanize rubber, sulfuric acid	**Sulfur**	S
Nonmetallic Luster	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris and drywall	**Gypsum** (Selenite)	$CaSO_4{\cdot}2H_2O$
Nonmetallic Luster	2–2.5	✔		colorless to yellow	flexible in thin sheets 	electrical insulator	**Muscovite Mica**	$KAl_3Si_3O_{10}(OH)_2$
Nonmetallic Luster	2.5	✔		colorless to white	cubic cleavage, salty taste 	food additive, melts ice	**Halite**	NaCl
Nonmetallic Luster	2.5–3	✔		black to dark brown	flexible in thin sheets 	electrical insulator	**Biotite Mica**	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$
Nonmetallic Luster	3	✔		colorless or variable	bubbles with acid 	cement, polarizing prisms	**Calcite**	$CaCO_3$
Nonmetallic Luster	3.5	✔		colorless or variable	bubbles with acid when powdered	source of magnesium	**Dolomite**	$CaMg(CO_3)_2$
Nonmetallic Luster	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	**Fluorite**	CaF_2
Nonmetallic Luster	5–6	✔		black to dark green	cleaves in 2 directions at 90° 	mineral collections	**Pyroxene** (commonly Augite)	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$
Nonmetallic Luster	5.5	✔		black to dark green	cleaves at 56° and 124° 	mineral collections	**Amphiboles** (commonly Hornblende)	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$
Nonmetallic Luster	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics and glass	**Potassium Feldspar** (Orthoclase)	$KAlSi_3O_8$
Nonmetallic Luster	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics and glass	**Plagioclase Feldspar** (Na-Ca Feldspar)	$(Na,Ca)AlSi_3O_8$
Nonmetallic Luster	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks and jewelry	**Olivine**	$(Fe,Mg)_2SiO_4$
Nonmetallic Luster	7		✔	colorless or variable	glassy luster, may form hexagonal crystals 	glass, jewelry, and electronics	**Quartz**	SiO_2
Nonmetallic Luster	7		✔	dark red to green	glassy luster, often seen as red grains in NYS metamorphic rocks	jewelry and abrasives	**Garnet** (commonly Almandine)	$Fe_3Al_2Si_3O_{12}$

*Chemical Symbols: Al = aluminum, C = carbon, Ca = calcium, Cl = chlorine, F = fluorine, Fe = iron, H = hydrogen, K = potassium, Mg = magnesium, Na = sodium, O = oxygen, Pb = lead, S = sulfur, Si = silicon, Ti = titanium

✔ = dominant form of breakage