

Earth Science Reference Tables

PHYSICAL CONSTANTS

Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$C^{14} \rightarrow N^{14}$	5.7×10^3
Potassium-40	$K^{40} \rightarrow \begin{matrix} Ar^{40} \\ Ca^{40} \end{matrix}$	1.3×10^9
Uranium-238	$U^{238} \rightarrow Pb^{206}$	4.5×10^9
Rubidium-87	$Rb^{87} \rightarrow Sr^{87}$	4.9×10^{10}

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (calories/gram • C°)	
Water {	solid	0.5
	liquid	1.0
	gas	0.5
Dry air	0.24	
Basalt	0.20	
Granite	0.19	
Iron	0.11	
Copper	0.09	
Lead	0.03	

Properties of Water

Energy gained during melting	80 calories/gram
Energy released during freezing	80 calories/gram
Energy gained during vaporization	540 calories/gram
Energy released during condensation	540 calories/gram
Density at 3.98°C	1.00 gram/milliliter

EQUATIONS

Percent deviation from accepted value

$$\text{deviation (\%)} = \frac{\text{difference from accepted value}}{\text{accepted value}} \times 100$$

Eccentricity of an ellipse

$$\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

Gradient

$$\text{gradient} = \frac{\text{change in field value}}{\text{distance}}$$

Rate of change

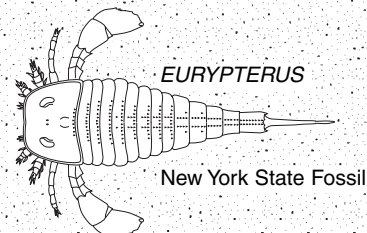
$$\text{rate of change} = \frac{\text{change in field value}}{\text{time}}$$

Density of a substance

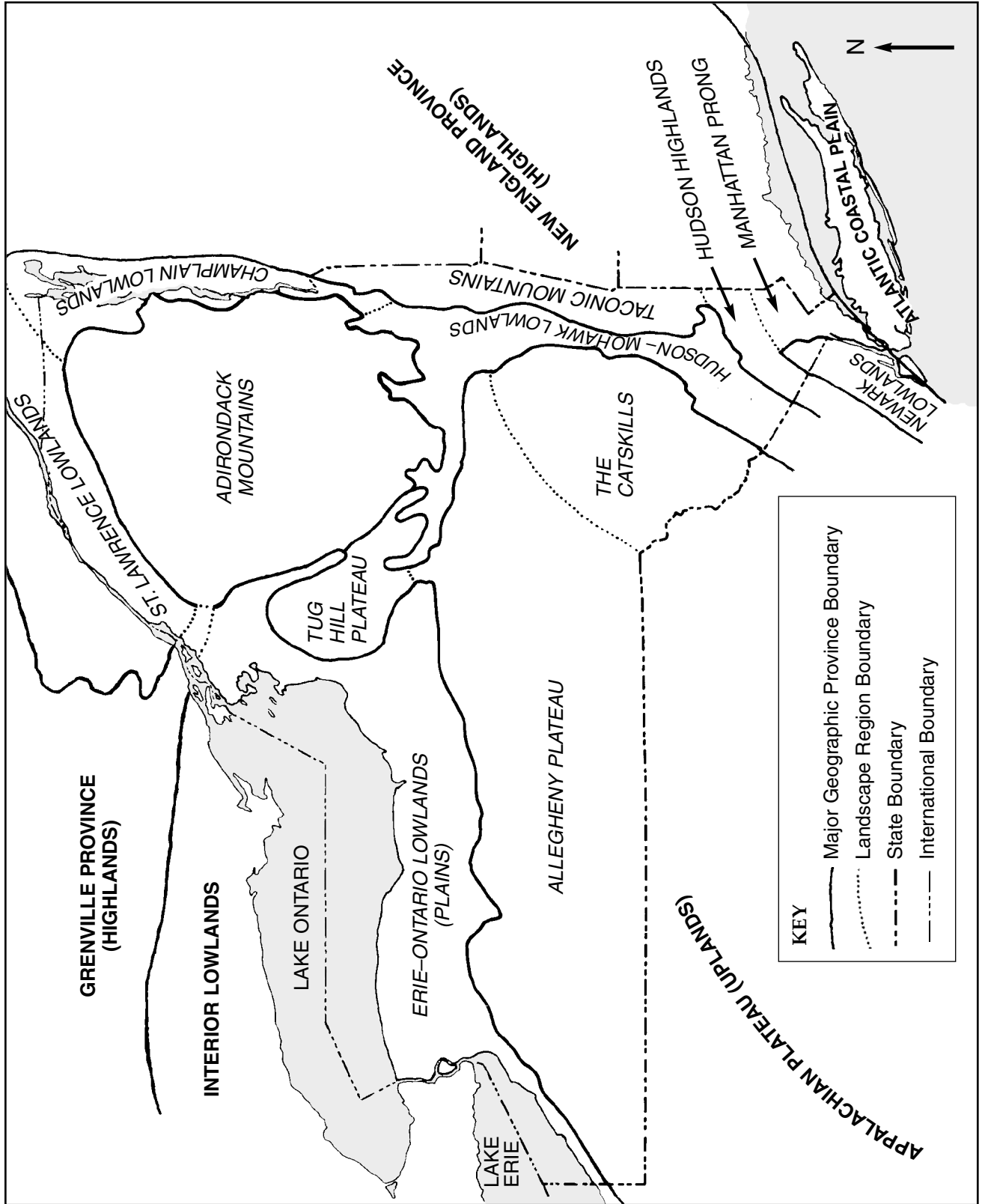
$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

2001 EDITION

This edition of the Earth Science Reference Tables should be used in the classroom beginning in the 2000–2001 school year. The first examination for which these tables will be used is the January 2001 Regents Examination in Earth Science.

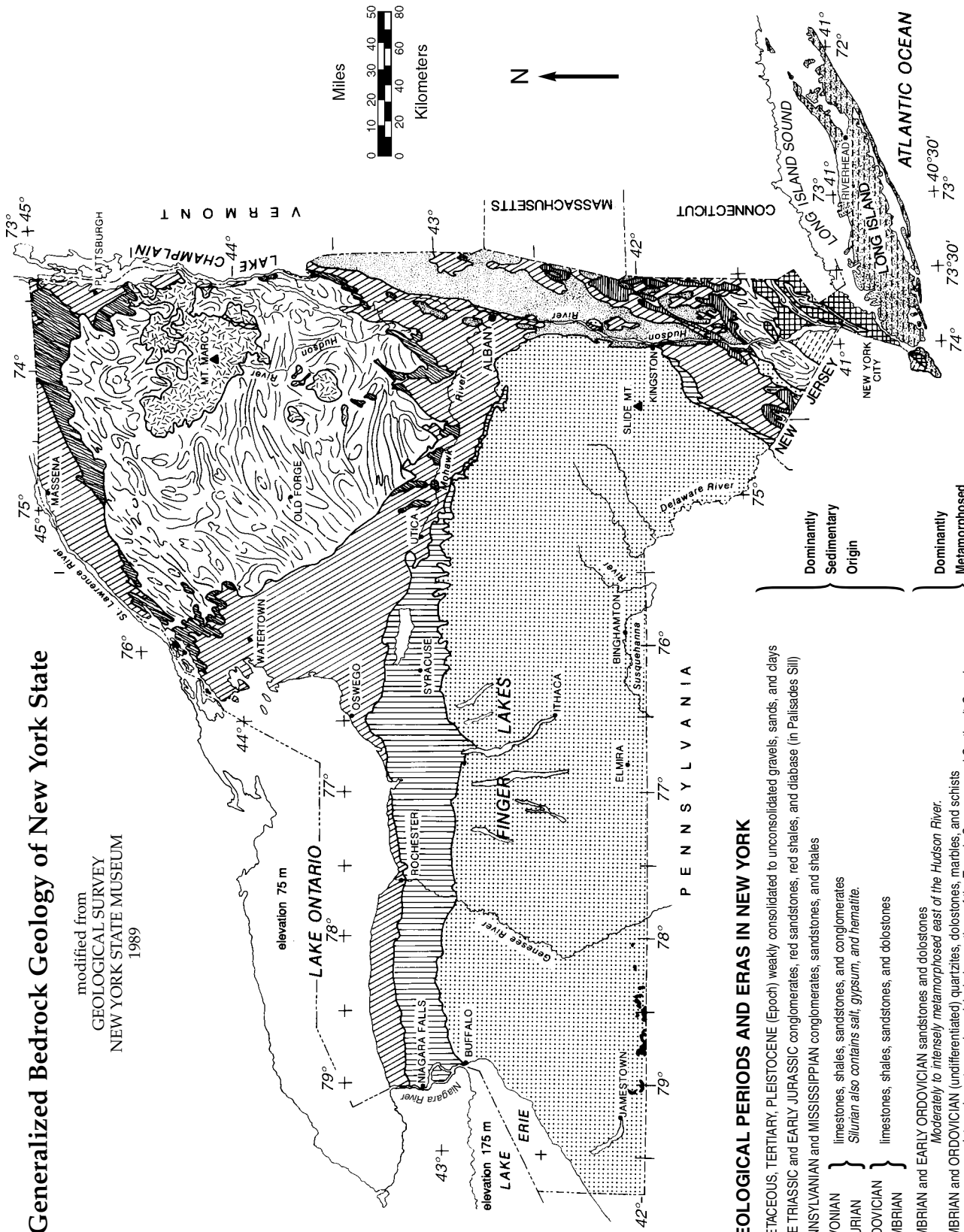


Generalized Landscape Regions of New York State



Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



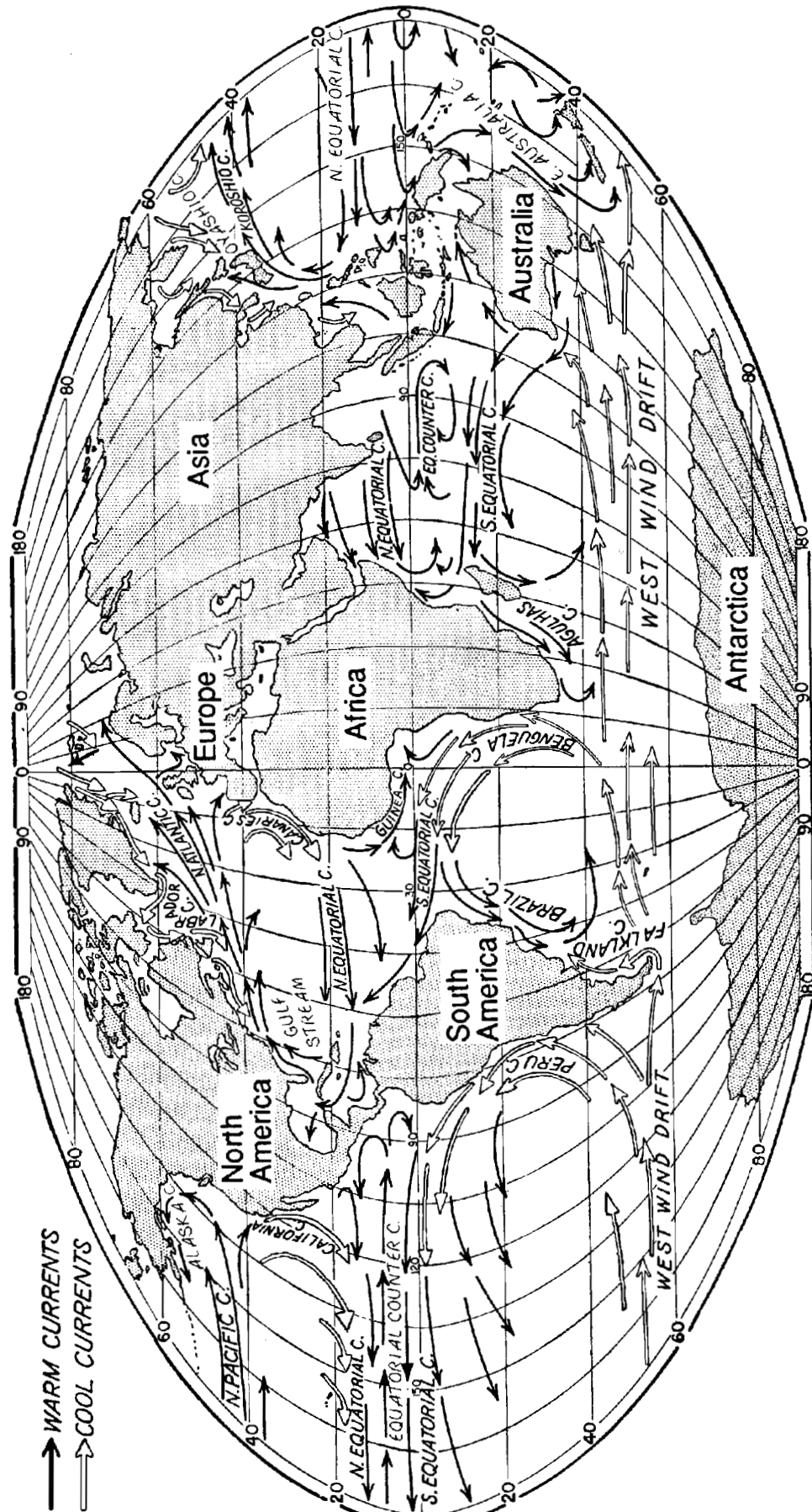
GEOLOGICAL PERIODS AND ERAS IN NEW YORK

- CRETACEOUS, TERTIARY, PLEISTOCENE (Epoch) weakly consolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red shales, and diabase (in Palisades Sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN } limestones, shales, sandstones, and conglomerates
- SILURIAN } Silurian also contains salt, gypsum, and hematite.
- ORDOVICIAN } limestones, shales, sandstones, and dolostones
- CAMBRIAN } limestones, shales, sandstones, and dolostones
- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones
Moderately to intensely metamorphosed east of the Hudson River.
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists
intensely metamorphosed; includes portions of the Taconic Sequence and Corlandt Complex.
- TACONIC SEQUENCE sandstones, shales, and slates
Slightly to intensely metamorphosed rocks of CAMBRIAN through MIDDLE ORDOVICIAN ages.
- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles
Lines are generalized structure trends.
- MIDDLE PROTEROZOIC anorthositic rocks
Intensely Metamorphosed Rocks
(regional metamorphism about 1,000 m.y.a.)

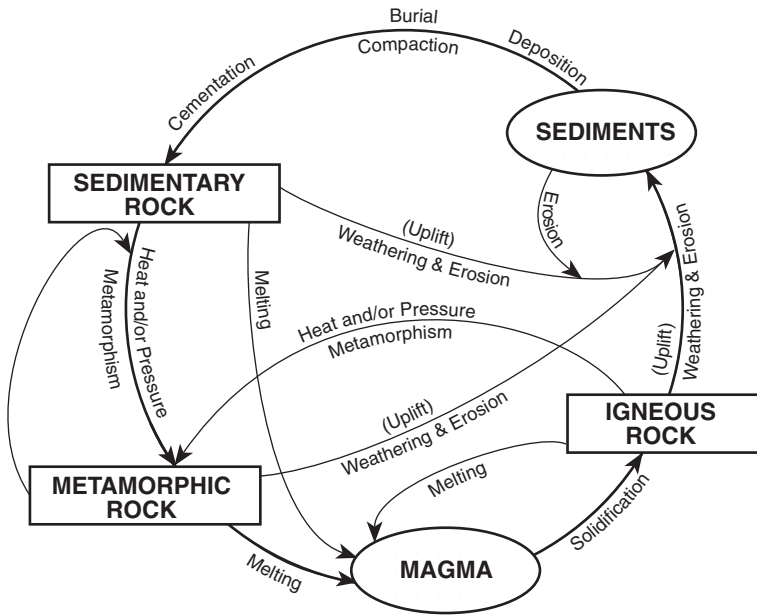
Dominantly Sedimentary Origin

Dominantly Metamorphosed Rocks

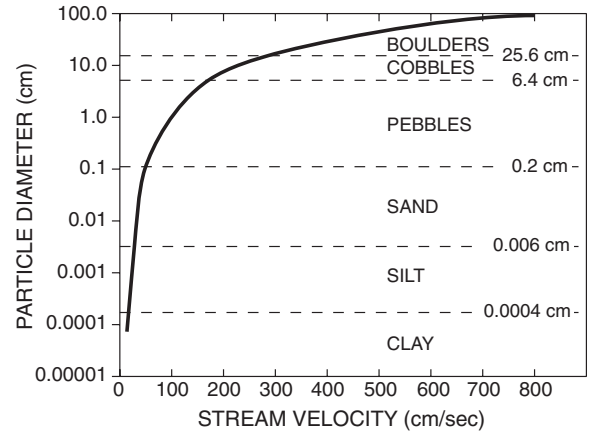
Surface Ocean Currents



Rock Cycle in Earth's Crust



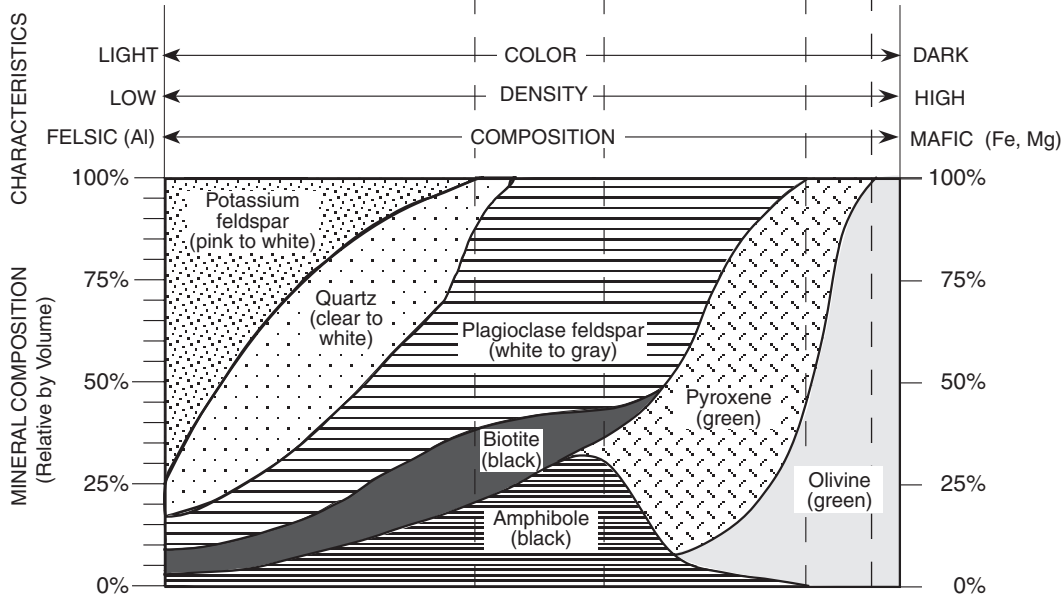
Relationship of Transported Particle Size to Water Velocity




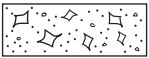
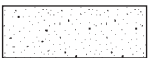
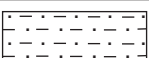

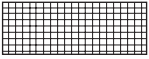
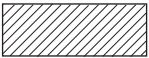
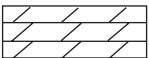
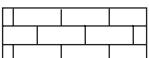

*This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

Scheme for Igneous Rock Identification









				GRAIN SIZE		TEXTURE		
IGNEOUS ROCKS	ENVIRONMENT OF FORMATION EXTRUSIVE (Volcanic)	Obsidian (usually appears black)		Basaltic Glass		Non-crystalline	Glassy	Non-vesicular
		Pumice		Vesicular Basaltic Glass				
		Vesicular Rhyolite	Vesicular Andesite	Scoria / Vesicular Basalt		less than 1 mm	Fine	Vesicular (gas pockets)
		Rhyolite	Andesite	Basalt				
		Granite	Diorite	Gabbro	Peridotite Dunite			
		Pegmatite				10 mm or larger	Very Coarse	



Scheme for Sedimentary Rock Identification

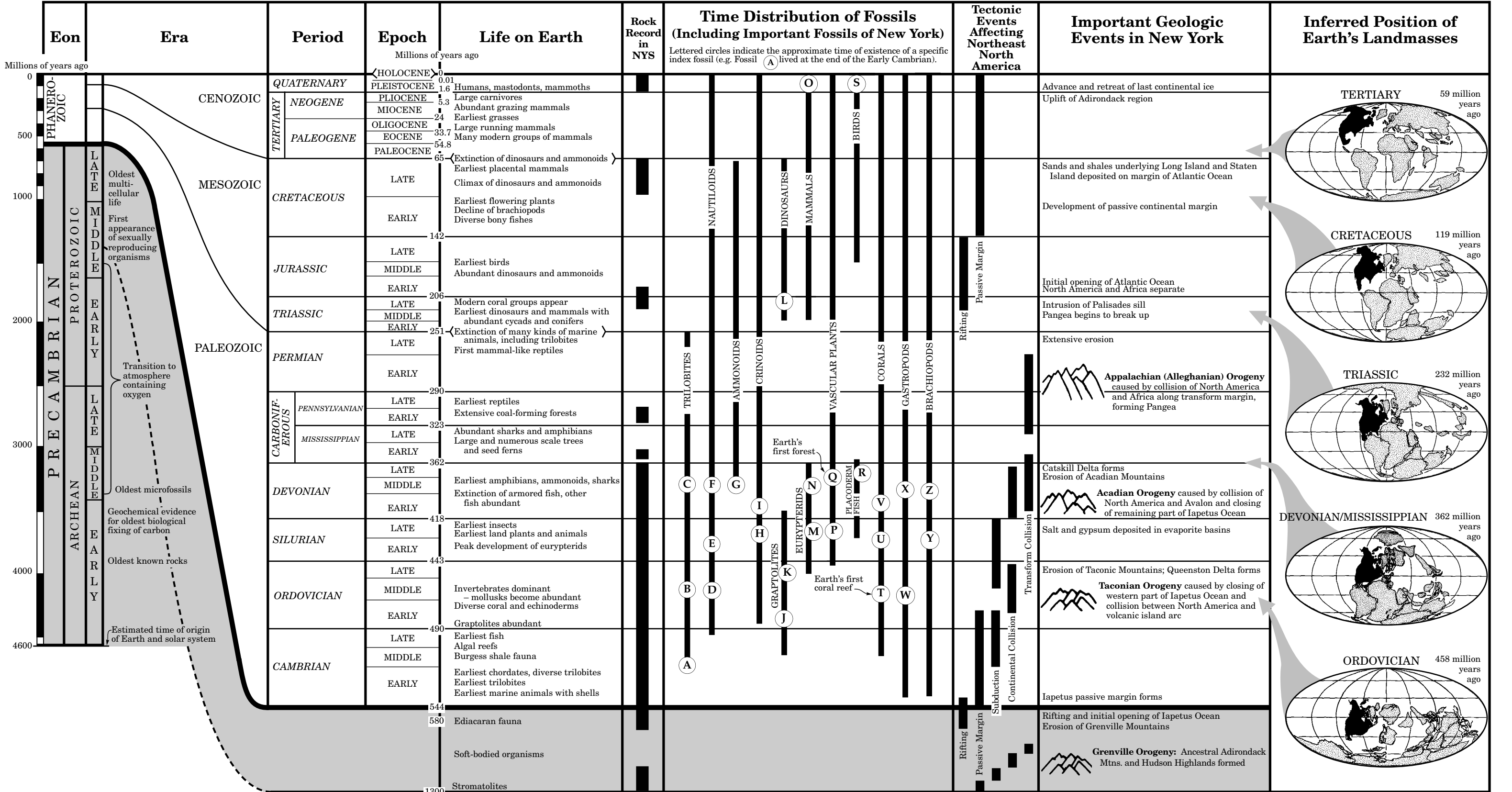
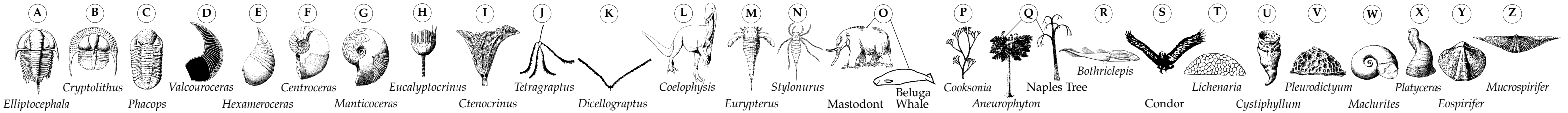
INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	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	

Scheme for Metamorphic Rock Identification

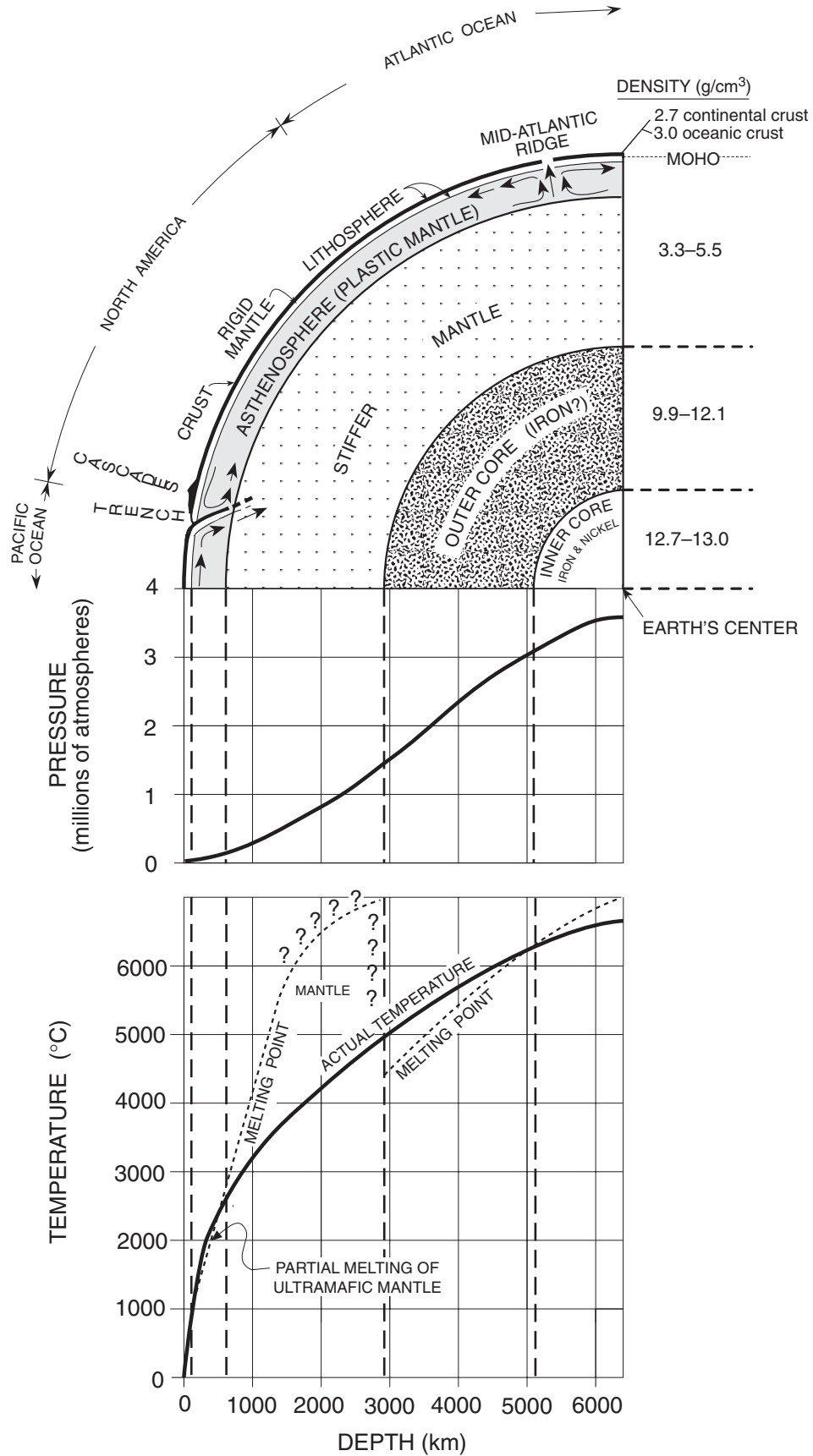
TEXTURE	GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED MINERAL ALIGNMENT BAND- ING	Fine	MICA QUARTZ FELDSPAR AMPHIBOLE GARNET PYROXENE	Regional (Heat and pressure increase with depth) ↓	Low-grade metamorphism of shale	Slate	
	Fine to medium			Foliation surfaces shiny from microscopic mica crystals	Phyllite	
	Medium to coarse			Platy mica crystals visible from metamorphism of clay or feldspars	Schist	
				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	
	Fine to coarse	Quartz	Regional or Contact	Metamorphism of quartz sandstone	Quartzite	
		Calcite and/or dolomite		Metamorphism of limestone or dolostone	Marble	
	Coarse	Various minerals in particles and matrix		Pebbles may be distorted or stretched	Metaconglomerate	

GEOLOGIC HISTORY OF NEW YORK STATE

(Fossils not drawn to scale)



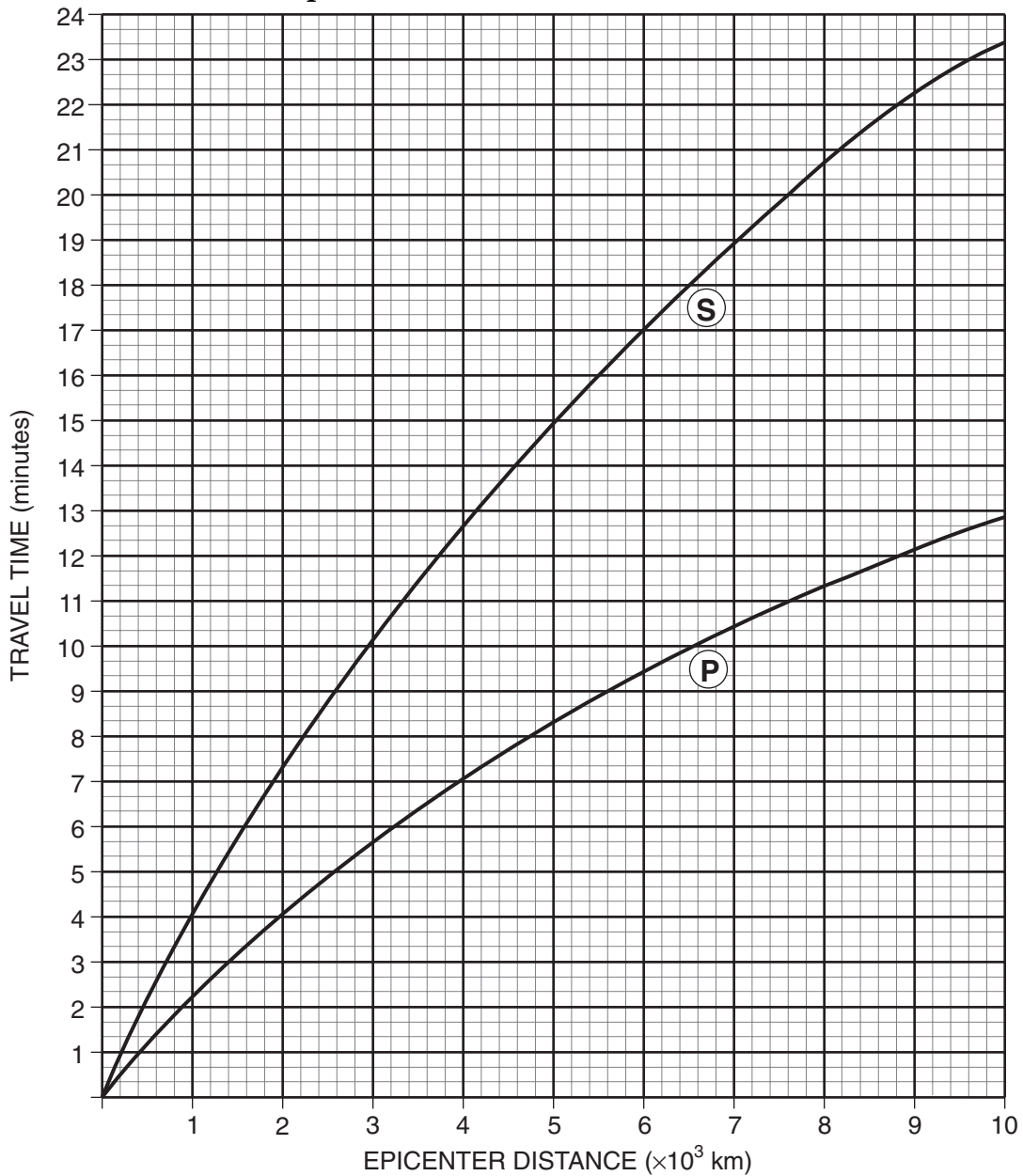
Inferred Properties of Earth's Interior



Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by Mass	Percent by Volume	Percent by Volume	Percent by Volume
Oxygen (O)	46.40	94.04	33.0	21.0
Silicon (Si)	28.15	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.66	0.07	1.0	1.0

Earthquake P-wave and S-wave Travel Time



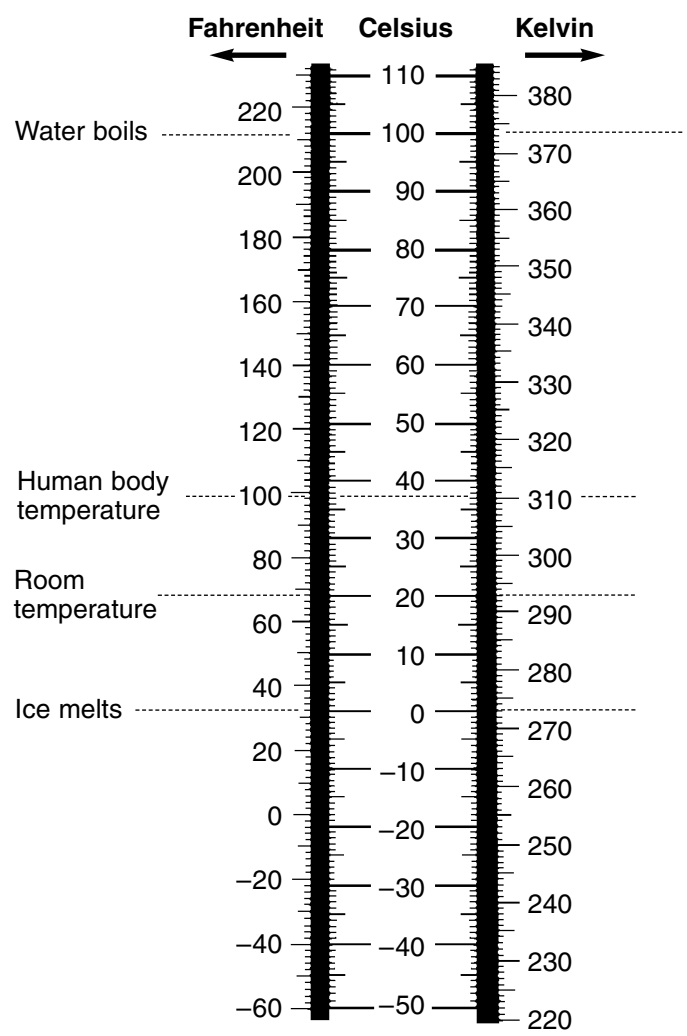
Dewpoint Temperatures (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	-20	-33														
-18	-18	-28														
-16	-16	-24														
-14	-14	-21	-36													
-12	-12	-18	-28													
-10	-10	-14	-22													
-8	-8	-12	-18	-29												
-6	-6	-10	-14	-22												
-4	-4	-7	-12	-17	-29											
-2	-2	-5	-8	-13	-20											
0	0	-3	-6	-9	-15	-24										
2	2	-1	-3	-6	-11	-17										
4	4	1	-1	-4	-7	-11	-19									
6	6	4	1	-1	-4	-7	-13	-21								
8	8	6	3	1	-2	-5	-9	-14								
10	10	8	6	4	1	-2	-5	-9	-14	-28						
12	12	10	8	6	4	1	-2	-5	-9	-16						
14	14	12	11	9	6	4	1	-2	-5	-10	-17					
16	16	14	13	11	9	7	4	1	-1	-6	-10	-17				
18	18	16	15	13	11	9	7	4	2	-2	-5	-10	-19			
20	20	19	17	15	14	12	10	7	4	2	-2	-5	-10	-19		
22	22	21	19	17	16	14	12	10	8	5	3	-1	-5	-10	-19	
24	24	23	21	20	18	16	14	12	10	8	6	2	-1	-5	-10	-18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	-4	-9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	-3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

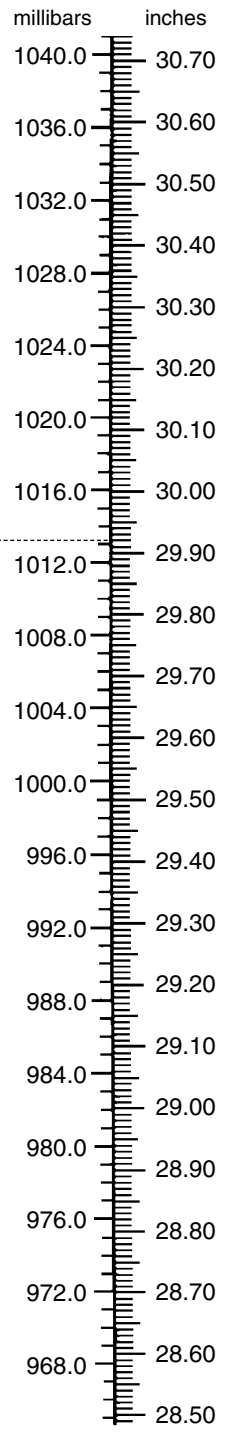
Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	100	28														
-18	100	40														
-16	100	48														
-14	100	55	11													
-12	100	61	23													
-10	100	66	33													
-8	100	71	41	13												
-6	100	73	48	20												
-4	100	77	54	32	11											
-2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

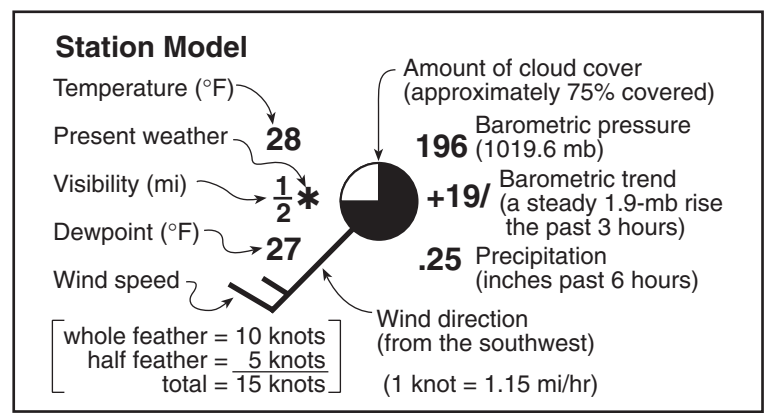
Temperature



Pressure

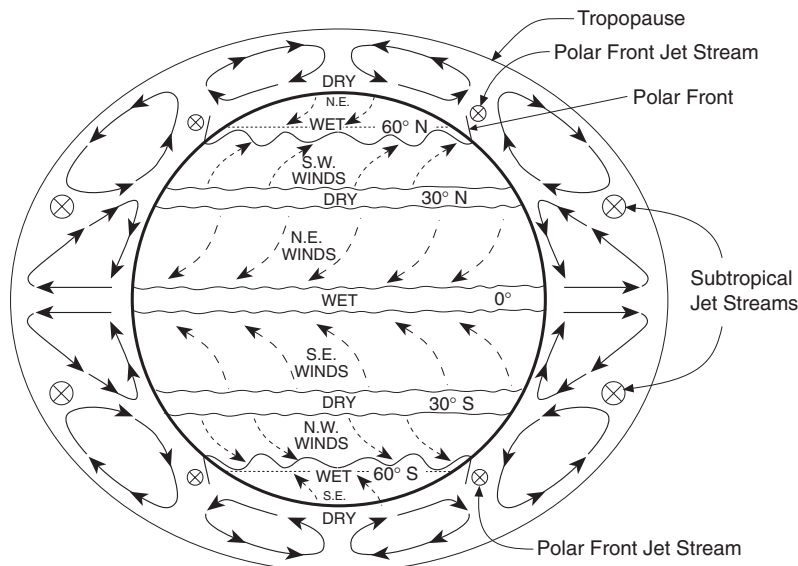
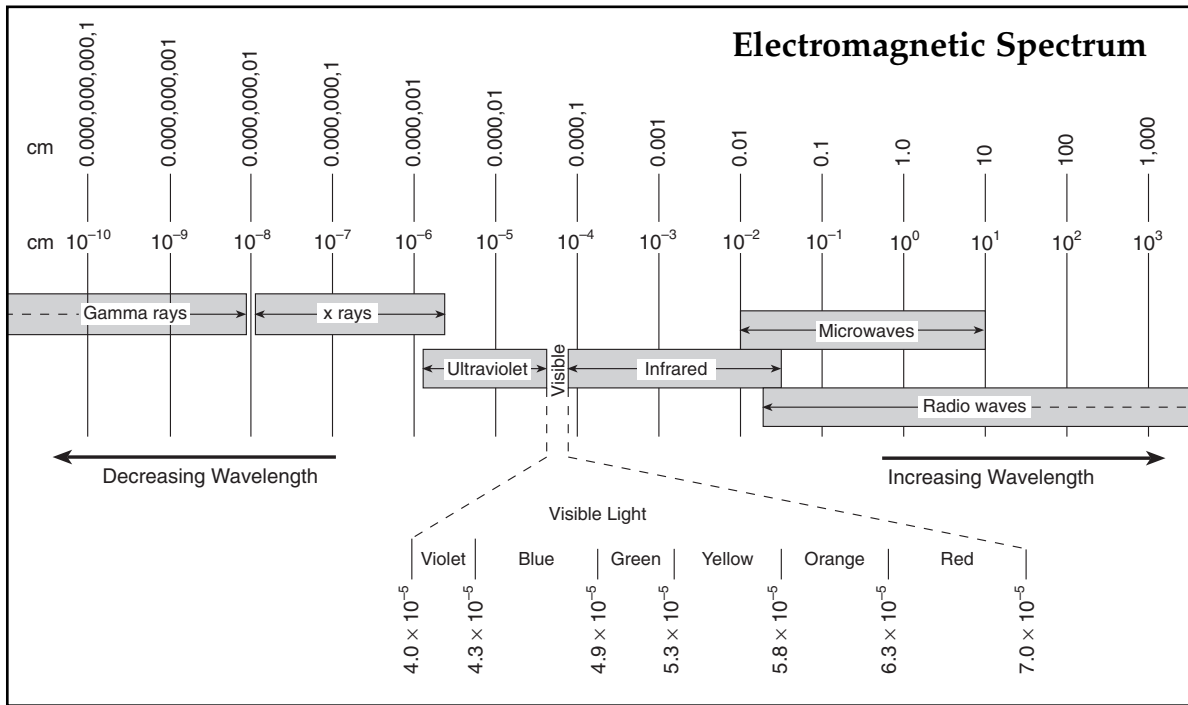
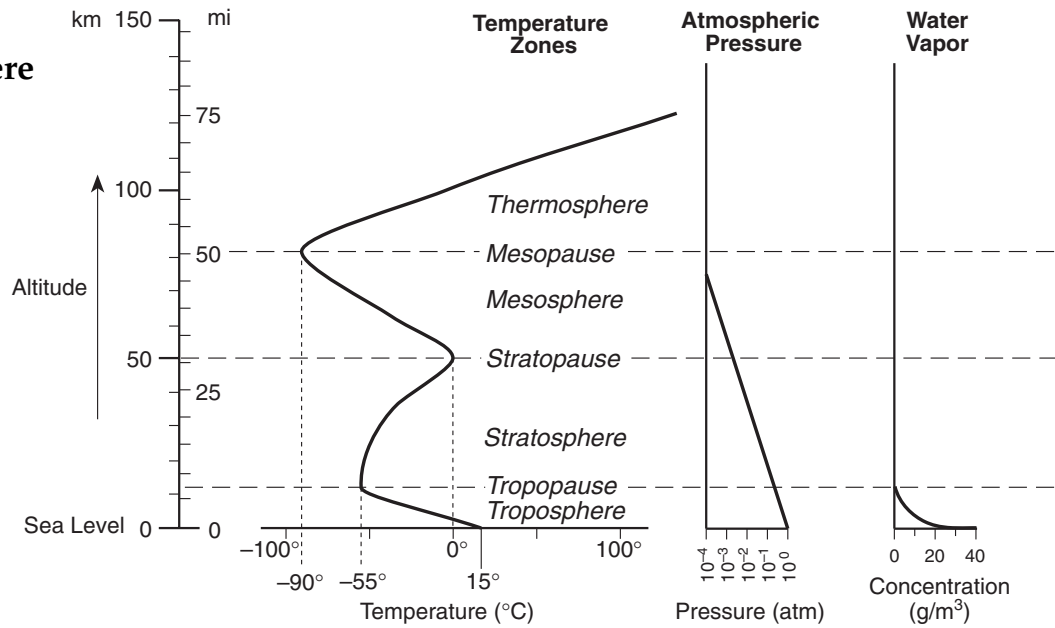


Weather Map Symbols



Present Weather						Air Masses				Front Symbols			Hurricane
☉ Drizzle	● Rain	☁ Smog	△ Hail	⚡ Thunderstorms	☂ Rain Showers	cA continental arctic	cP continental polar	cT continental tropical	mT maritime tropical	mP maritime polar	Cold	▲▲▲▲	☉
* Snow	◁ Sleet	❄ Freezing Rain	= Fog	∞ Haze	*☂ Snow Showers	Cold	Warm	Stationary	Occluded	Cold	▲▲▲▲		
						Cold	Warm	Stationary	Occluded	Warm	▲▲▲▲		
						Cold	Warm	Stationary	Occluded	Occluded	▲▲▲▲		

Selected Properties of Earth's Atmosphere

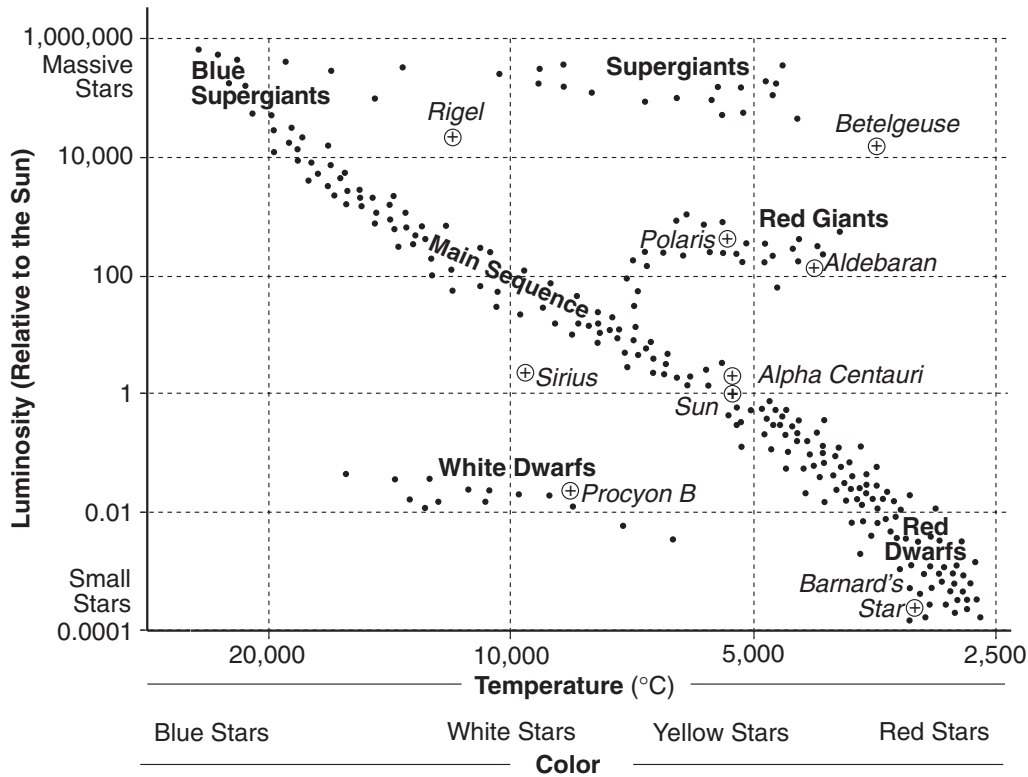


Planetary Wind and Moisture Belts in the Troposphere

The drawing to the left shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in summer and southward in winter.

Luminosity and Temperature of Stars

(Name in italics refers to star shown by a ⊕)












Luminosity is the brightness of stars compared to the brightness of our Sun as seen from the same distance from the observer.

Solar System Data

Object	Mean Distance from Sun (millions of km)	Period of Revolution	Period of Rotation	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm ³)	Number of Moons
SUN	—	—	27 days	—	1,392,000	333,000.00	1.4	—
MERCURY	57.9	88 days	59 days	0.206	4,880	0.553	5.4	0
VENUS	108.2	224.7 days	243 days	0.007	12,104	0.815	5.2	0
EARTH	149.6	365.26 days	23 hr 56 min 4 sec	0.017	12,756	1.00	5.5	1
MARS	227.9	687 days	24 hr 37 min 23 sec	0.093	6,787	0.1074	3.9	2
JUPITER	778.3	11.86 years	9 hr 50 min 30 sec	0.048	142,800	317.896	1.3	16
SATURN	1,427	29.46 years	10 hr 14 min	0.056	120,000	95.185	0.7	18
URANUS	2,869	84.0 years	17 hr 14 min	0.047	51,800	14.537	1.2	21
NEPTUNE	4,496	164.8 years	16 hr	0.009	49,500	17.151	1.7	8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 days	27 days 8 hr	0.055	3,476	0.0123	3.3	—

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
	2.5	✓	metallic silver	very dense (7.6 g/cm ³), gray-black streak 	ore of lead	Galena	PbS
	5.5–6.5	✓	black to silver	attracted by magnet, black streak	ore of iron	Magnetite	Fe ₃ O ₄
	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 ₂ O ₃
Nonmetallic Luster	1	✓	white to green	greasy feel	talcum powder, soapstone	Talc	Mg ₃ Si ₄ O ₁₀ (OH) ₂
	2	✓	yellow to amber	easily melted, may smell	vulcanize rubber, sulfuric acid	Sulfur	S
	2	✓	white to pink or gray	easily scratched by fingernail	plaster of paris and drywall	Gypsum (Selenite)	CaSO ₄ •2H ₂ O
	2–2.5	✓	colorless to yellow	flexible in thin sheets 	electrical insulator	Muscovite Mica	KAl ₃ Si ₃ O ₁₀ (OH) ₂
	2.5	✓	colorless to white	cubic cleavage, salty taste 	food additive, melts ice	Halite	NaCl
	2.5–3	✓	black to dark brown	flexible in thin sheets 	electrical insulator	Biotite Mica	K(Mg,Fe) ₃ AlSi ₃ O ₁₀ (OH) ₂
	3	✓	colorless or variable	bubbles with acid 	cement, polarizing prisms	Calcite	CaCO ₃
	3.5	✓	colorless or variable	bubbles with acid when powdered	source of magnesium	Dolomite	CaMg(CO ₃) ₂
	4	✓	colorless or variable	cleaves in 4 directions	hydrofluoric acid	Fluorite	CaF ₂
	5–6	✓	black to dark green	cleaves in 2 directions at 90° 	mineral collections	Pyroxene (commonly Augite)	(Ca,Na)(Mg,Fe,Al)(Si,Al) ₂ O ₆
	5.5	✓	black to dark green	cleaves at 56° and 124° 	mineral collections	Amphiboles (commonly Hornblende)	CaNa(Mg,Fe) ₄ (Al,Fe,Ti) ₃ Si ₆ O ₂₂ (O,OH) ₂
	6	✓	white to pink	cleaves in 2 directions at 90°	ceramics and glass	Potassium Feldspar (Orthoclase)	KAlSi ₃ O ₈
	6	✓	white to gray	cleaves in 2 directions, striations visible	ceramics and glass	Plagioclase Feldspar (Na-Ca Feldspar)	(Na,Ca)AlSi ₃ O ₈
	6.5	✓	green to gray or brown	commonly light green and granular	furnace bricks and jewelry	Olivine	(Fe,Mg) ₂ SiO ₄
7	✓	colorless or variable	glassy luster, may form hexagonal crystals 	glass, jewelry, and electronics	Quartz	SiO ₂	
7	✓	dark red to green	glassy luster, often seen as red grains in NYS metamorphic rocks	jewelry and abrasives	Garnet (commonly Almandine)	Fe ₃ Al ₂ Si ₃ O ₁₂	

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

✓ = dominant form of breakage