

Air Masses

cA continental arctic

cP continental polar

cT continental tropical

mT maritime tropical

mP maritime polar

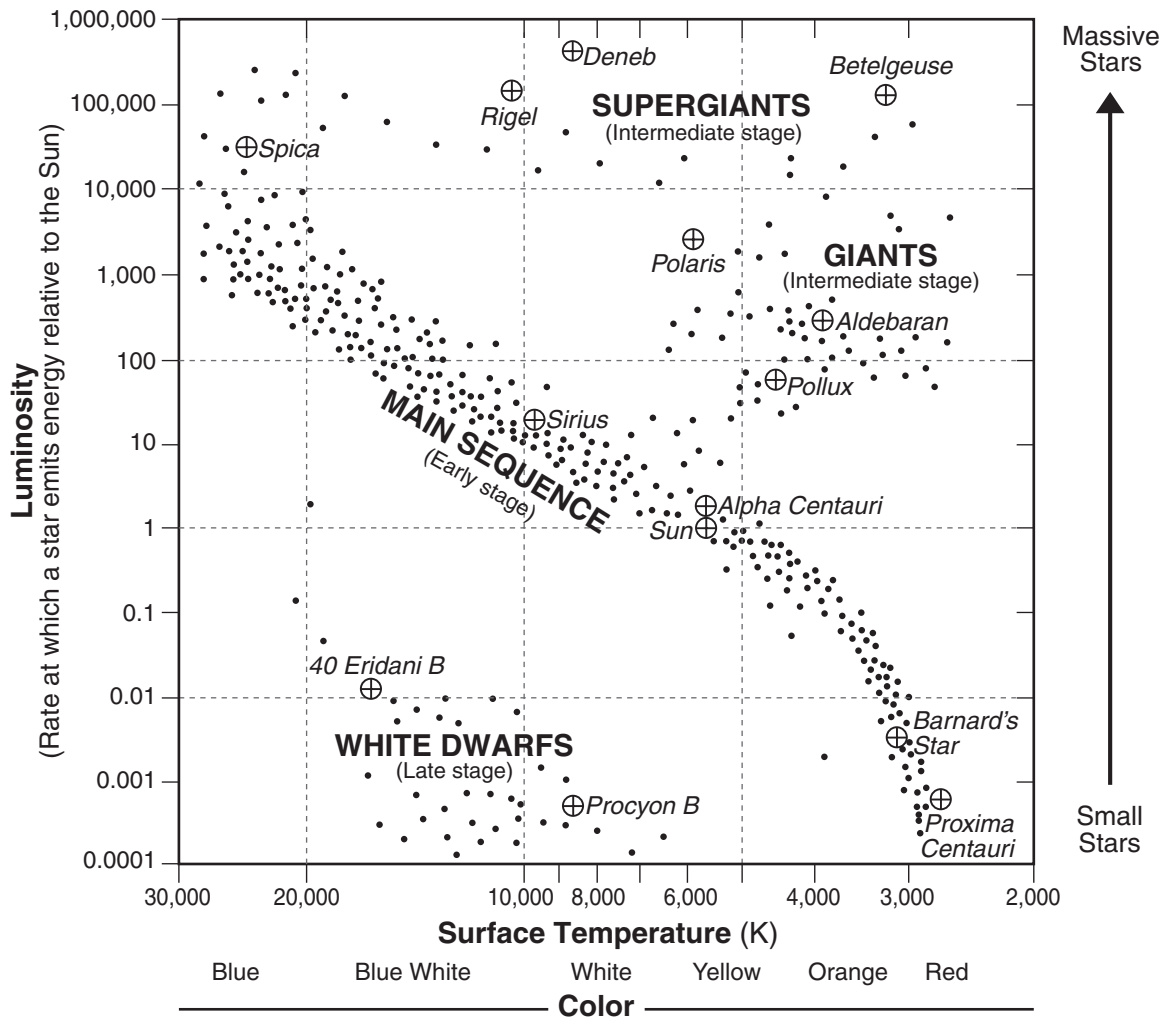
Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	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	0.91	0.07	1.0	1.0

Characteristics of Stars

(Name in *italics* refers to star represented by a ⊕.)

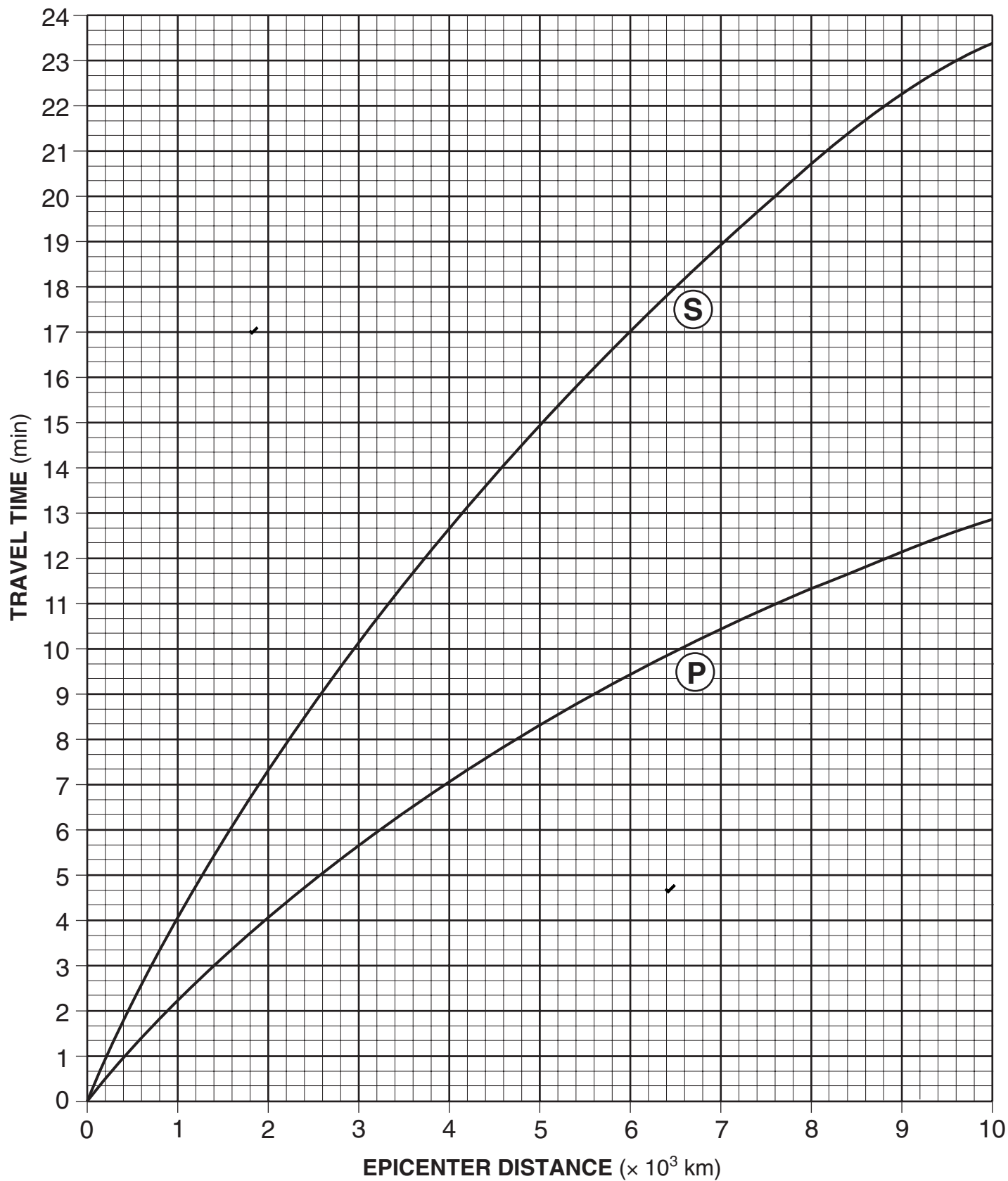
(Stages indicate the general sequence of star development.)



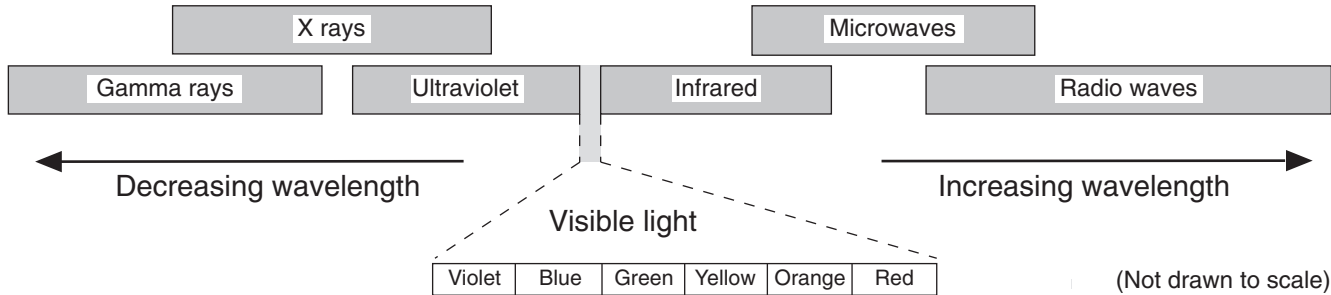
Dewpoint (°C)

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

Earthquake P-Wave and S-Wave Travel Time



Electromagnetic Spectrum



Equations

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

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

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

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

Fronts

Cold



Warm



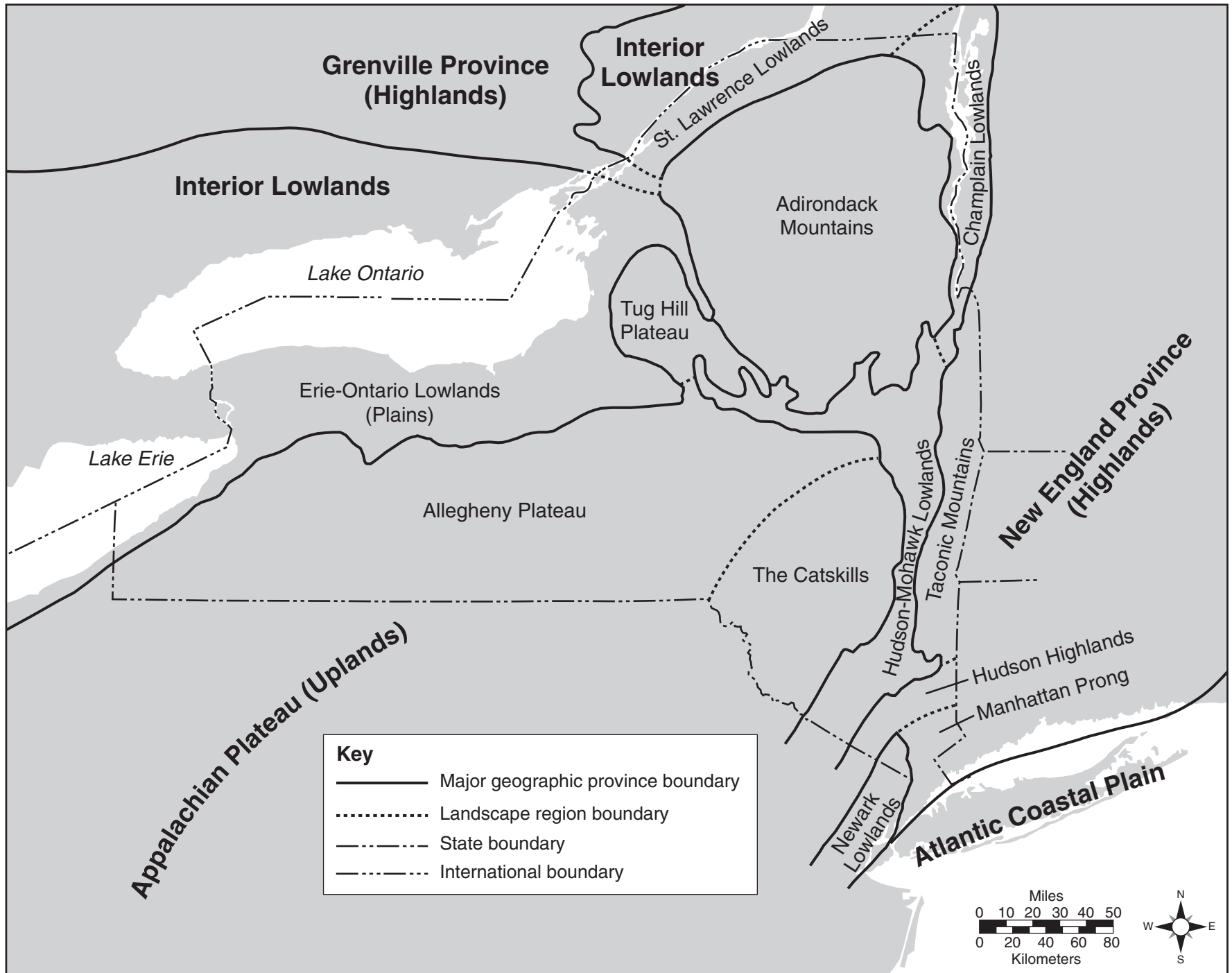
Stationary



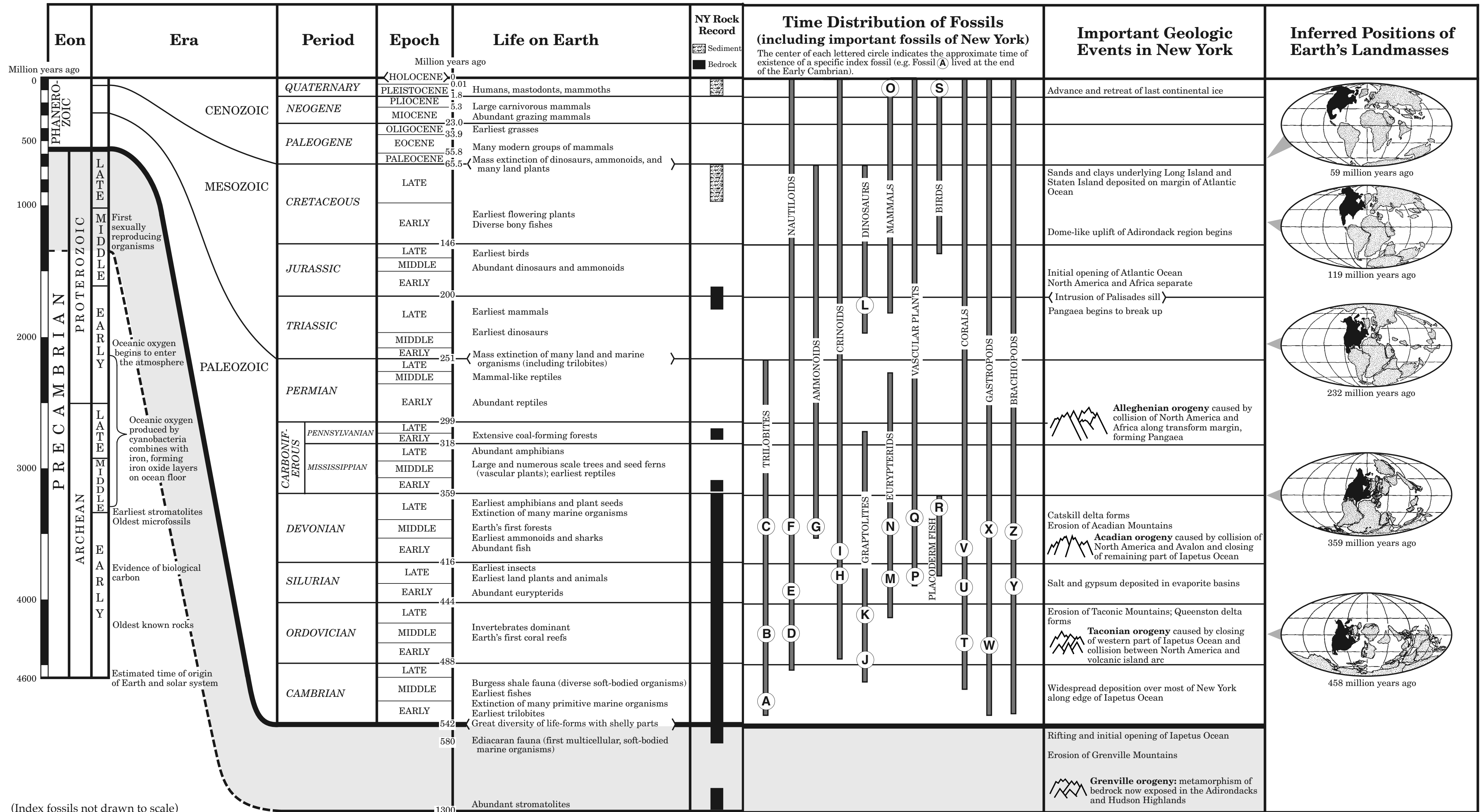
Occluded



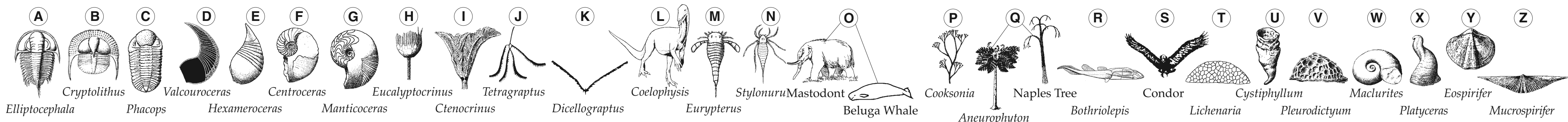
Generalized Landscape Regions of New York State



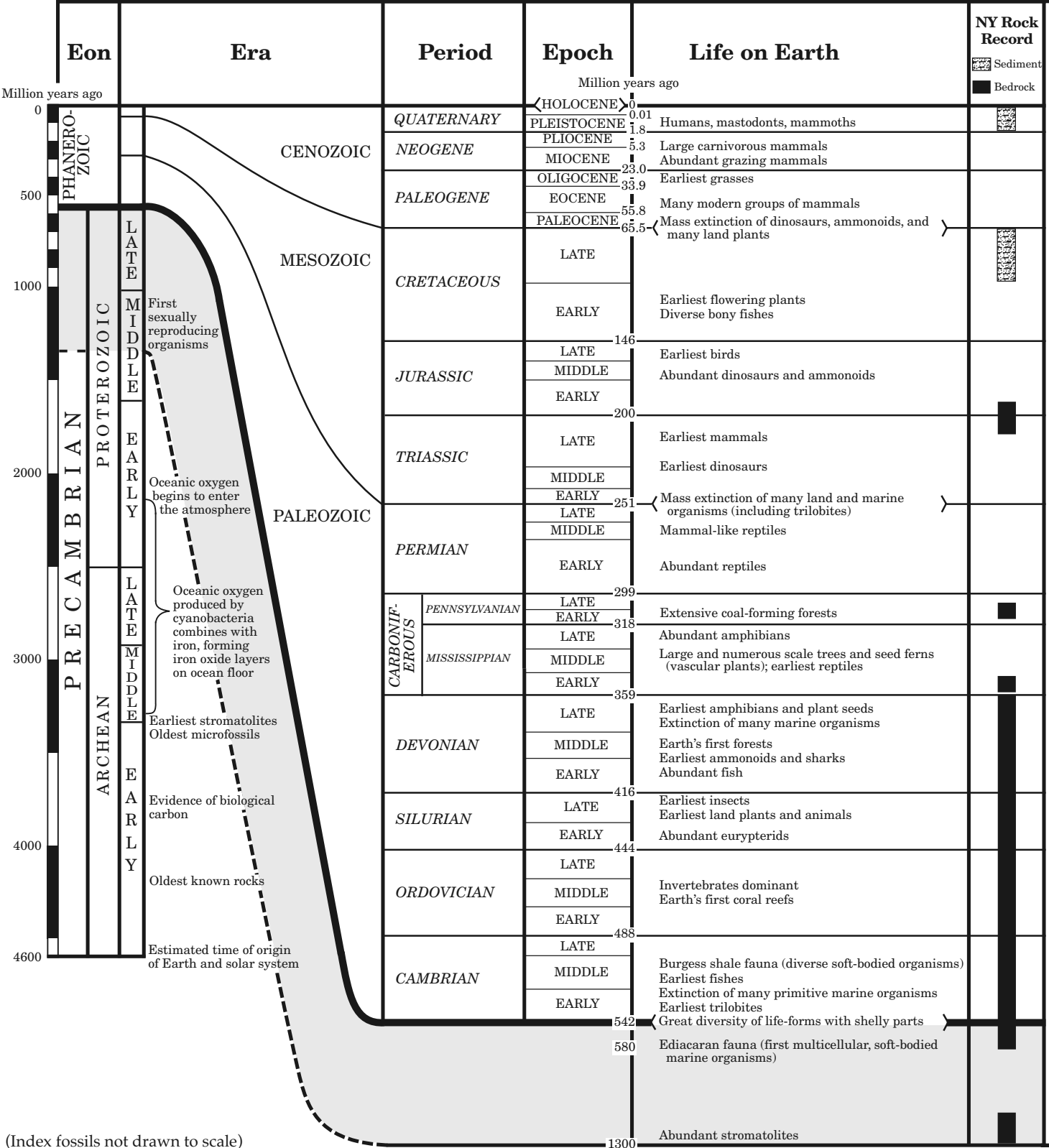
GEOLOGIC HISTORY OF NEW YORK STATE



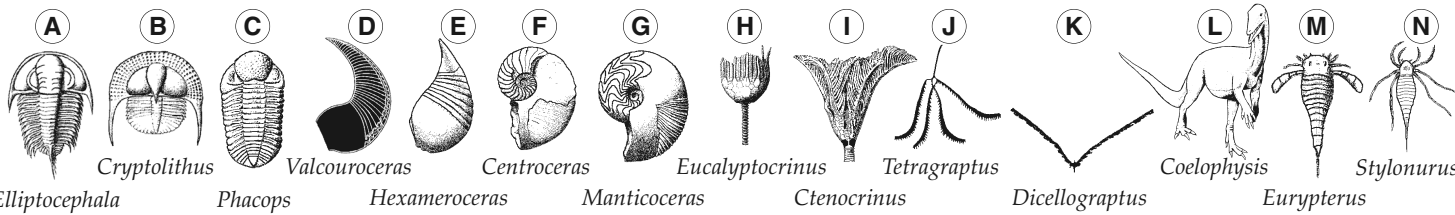
(Index fossils not drawn to scale)



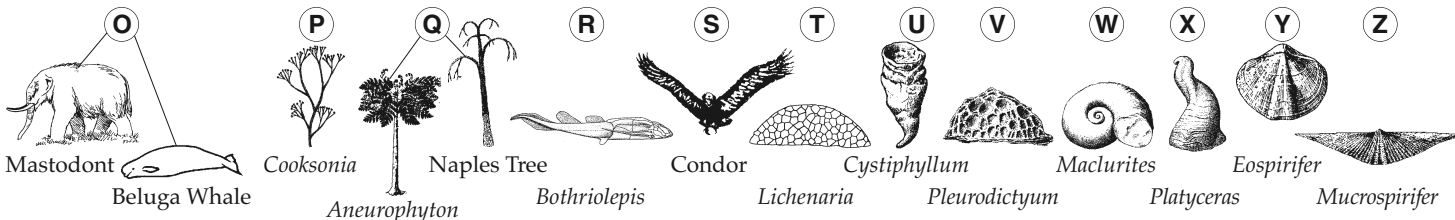
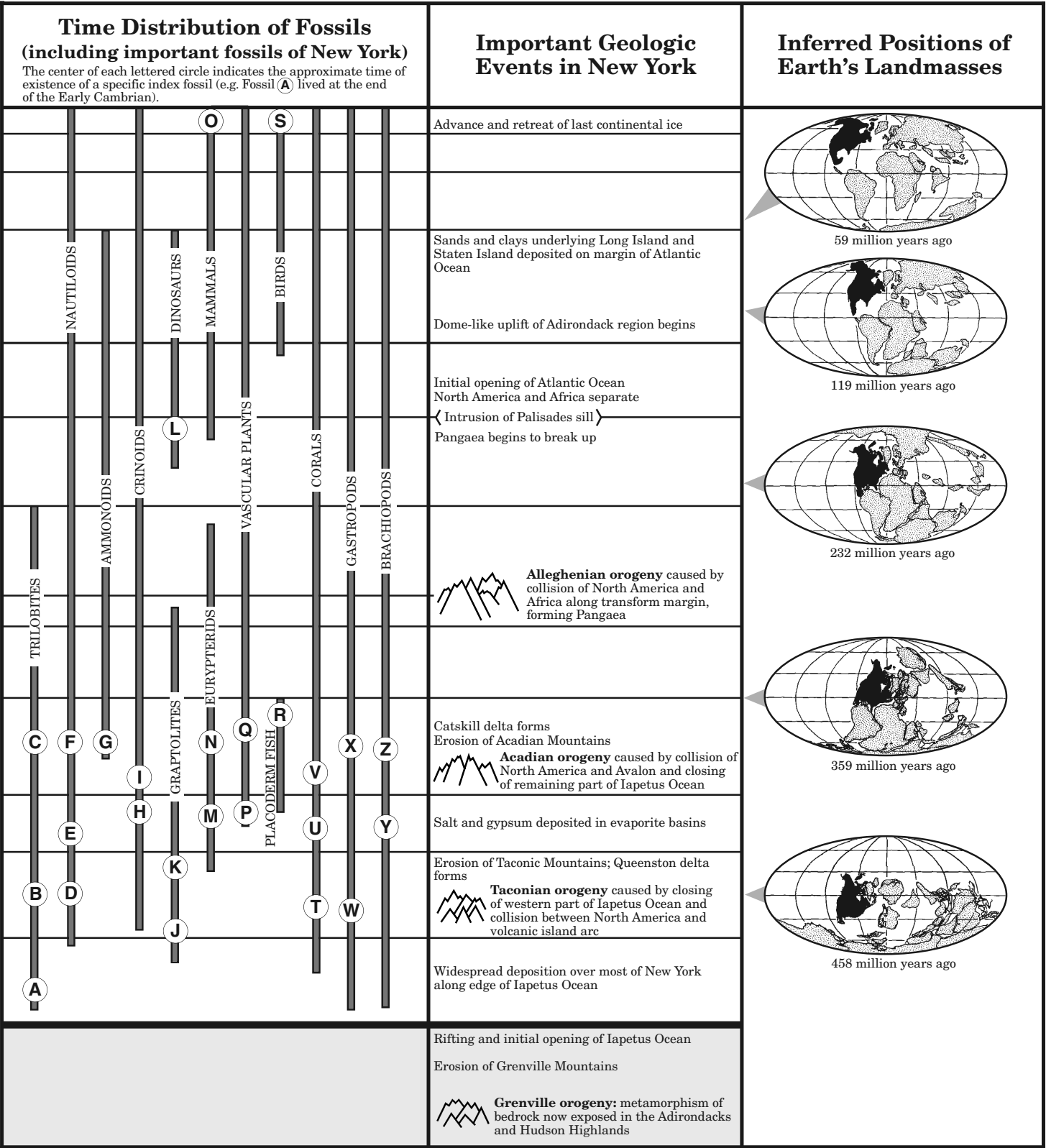
GEOLOGIC HISTORY



(Index fossils not drawn to scale)



OF NEW YORK STATE



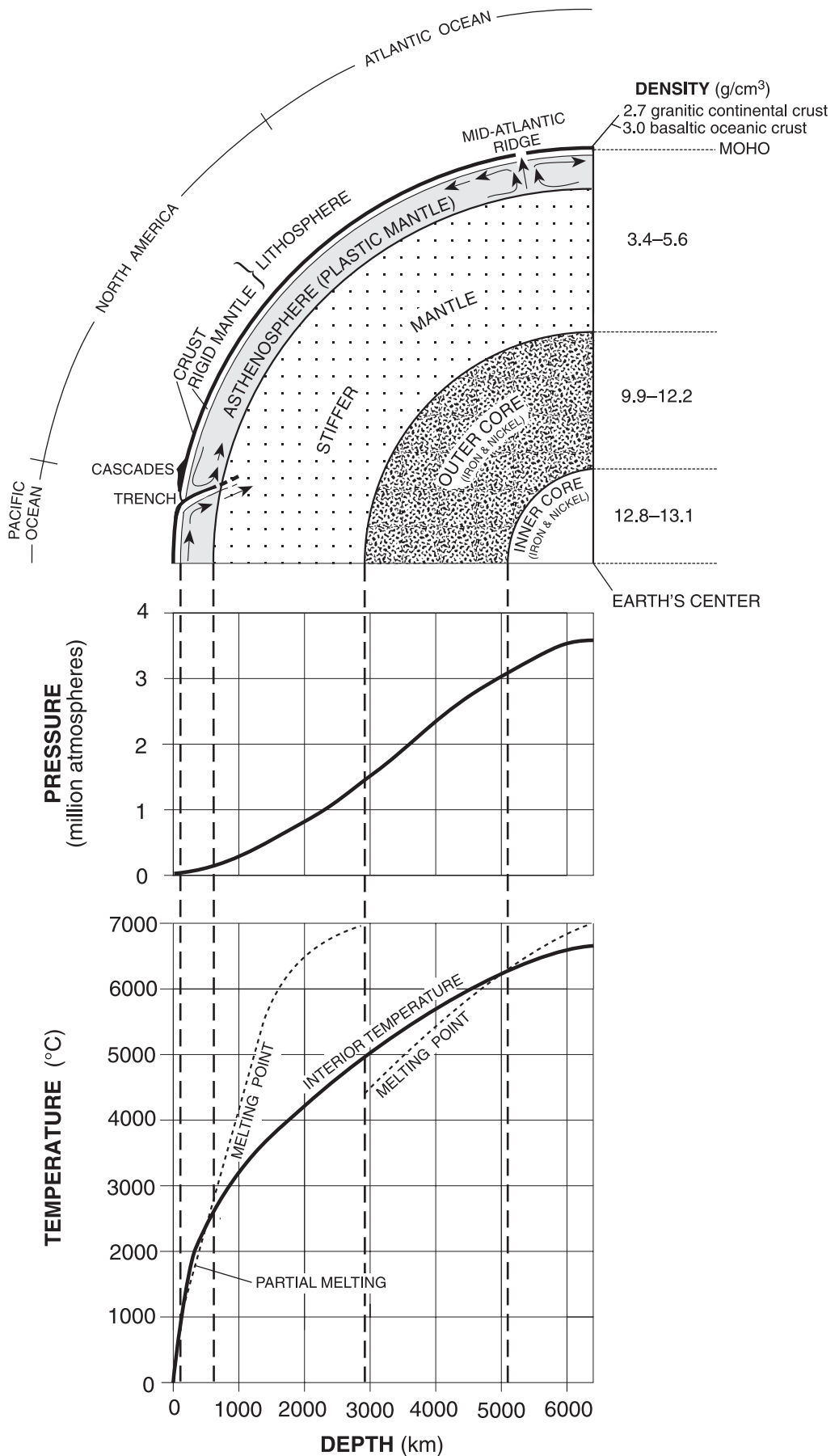
Hurricane



Tornado

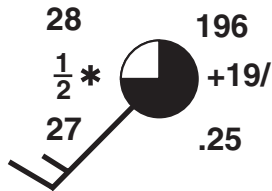


Inferred Properties of Earth's Interior

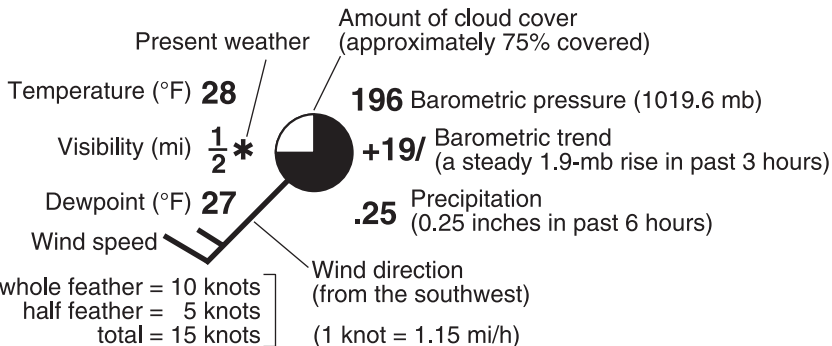


Key to Weather Map Symbols

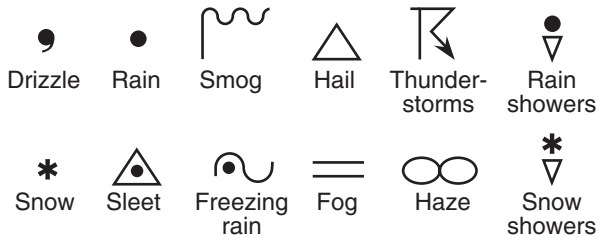
Station Model



Station Model Explanation



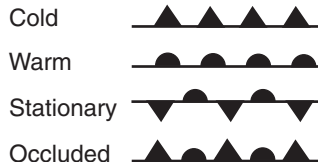
Present Weather



Air Masses

cA continental arctic
cP continental polar
cT continental tropical
mT maritime tropical
mP maritime polar

Fronts



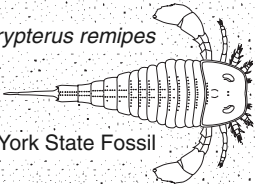
Hurricane



Tornado



Eurypterus remipes

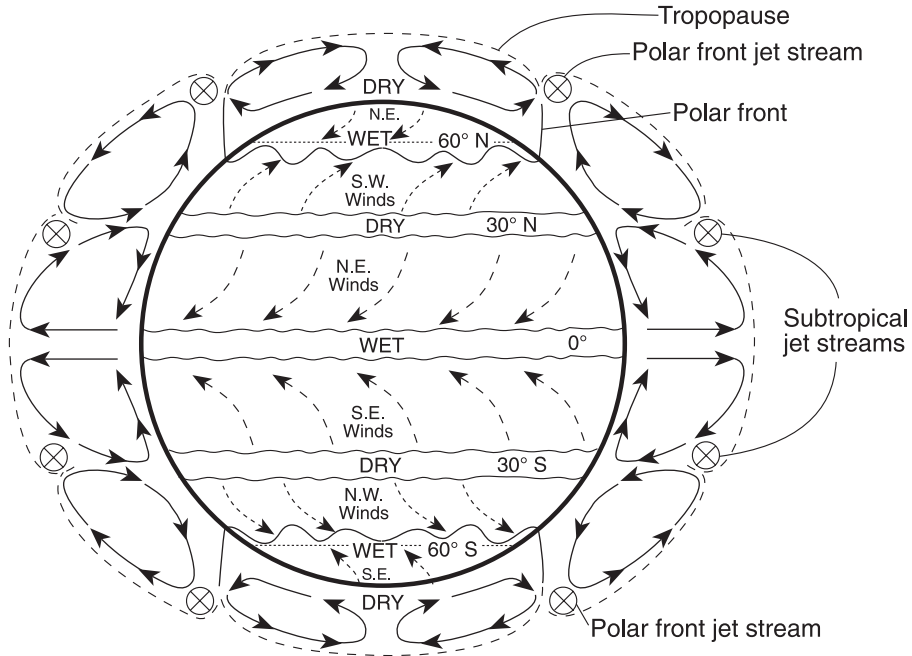


New York State Fossil

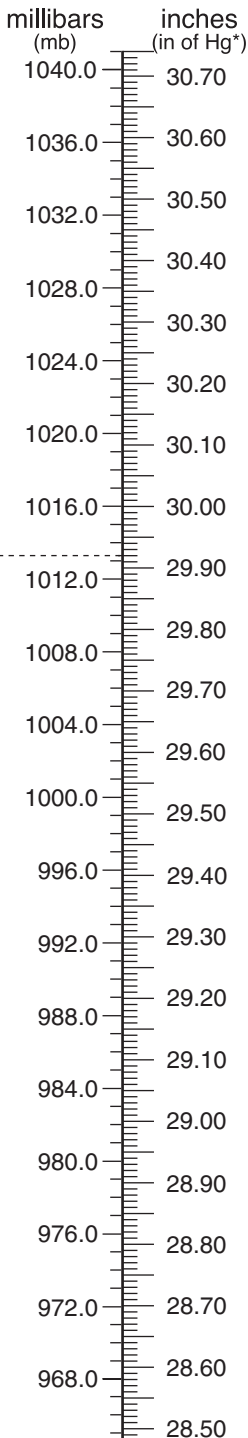
Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right 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 the summer and southward in the winter.

(Not drawn to scale)



Pressure



*Hg = mercury

Properties of Common Minerals

LUSTER	HARD- NESS	CLEAVAGE FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✓	silver to gray	black streak, greasy feel	pencil lead, lubricants	C	Graphite
	2.5	✓	metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm ³	ore of lead, batteries	PbS	Galena
	5.5–6.5	✓	black to silver	black streak, magnetic	ore of iron, steel	Fe ₃ O ₄	Magnetite
	6.5	✓	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS ₂	Pyrite
Either	5.5 – 6.5 or 1	✓	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe ₂ O ₃	Hematite
Nonmetallic luster	1	✓	white to green	greasy feel	ceramics, paper	Mg ₃ Si ₄ O ₁₀ (OH) ₂	Talc
	2	✓	yellow to amber	white-yellow streak	sulfuric acid	S	Sulfur
	2	✓	white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	CaSO ₄ •2H ₂ O	Selenite gypsum
	2–2.5	✓	colorless to yellow	flexible in thin sheets	paint, roofing	KAl ₃ Si ₃ O ₁₀ (OH) ₂	Muscovite mica
	2.5	✓	colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	Halite
	2.5–3	✓	black to dark brown	flexible in thin sheets	construction materials	K(Mg,Fe) ₃ AlSi ₃ O ₁₀ (OH) ₂	Biotite mica
	3	✓	colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	CaCO ₃	Calcite
	3.5	✓	colorless or variable	bubbles with acid when powdered	building stones	CaMg(CO ₃) ₂	Dolomite
	4	✓	colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF ₂	Fluorite
	5–6	✓	black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	(Ca,Na)(Mg,Fe,Al)(Si,Al) ₂ O ₆	Pyroxene (commonly augite)
	5.5	✓	black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	CaNa(Mg,Fe) ₄ (Al,Fe,Ti) ₃ Si ₆ O ₂₂ (O,OH) ₂	Amphibole (commonly hornblende)
	6	✓	white to pink	cleaves in 2 directions at 90°	ceramics, glass	KAlSi ₃ O ₈	Potassium feldspar (commonly orthoclase)
	6	✓	white to gray	cleaves in 2 directions, striations visible	ceramics, glass	(Na,Ca)AlSi ₃ O ₈	Plagioclase feldspar
	6.5	✓	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	(Fe,Mg) ₂ SiO ₄	Olivine
	7	✓	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO ₂	Quartz
	6.5–7.5	✓	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	Fe ₃ Al ₂ Si ₃ O ₁₂	Garnet

*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

Properties of Water

Heat energy gained during melting	334 J/g
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Heat energy released during freezing	334 J/g
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Heat energy gained during vaporization	2260 J/g
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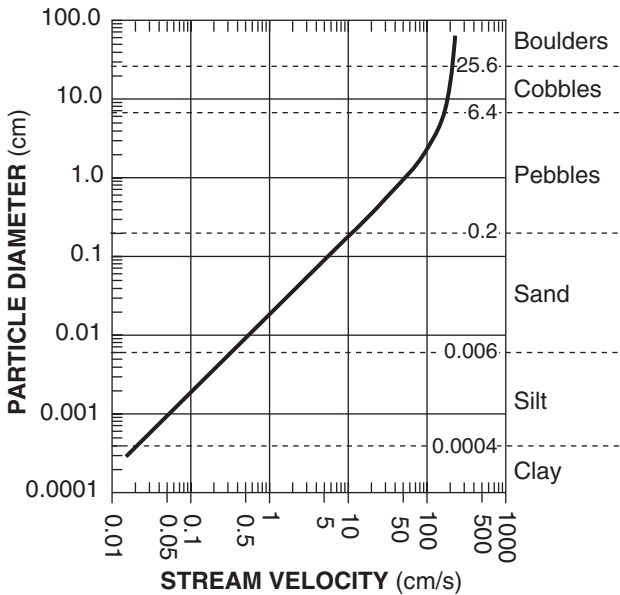
Heat energy released during condensation . . .	2260 J/g
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Density at 3.98°C	1.0 g/mL
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Radioactive Decay Data

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

Relationship of Transported Particle Size to Water Velocity

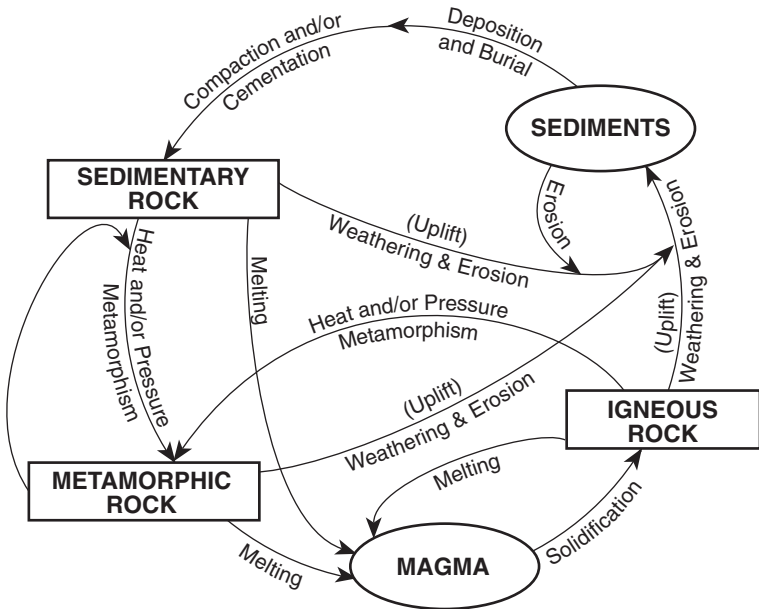


This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

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

Rock Cycle in Earth's Crust



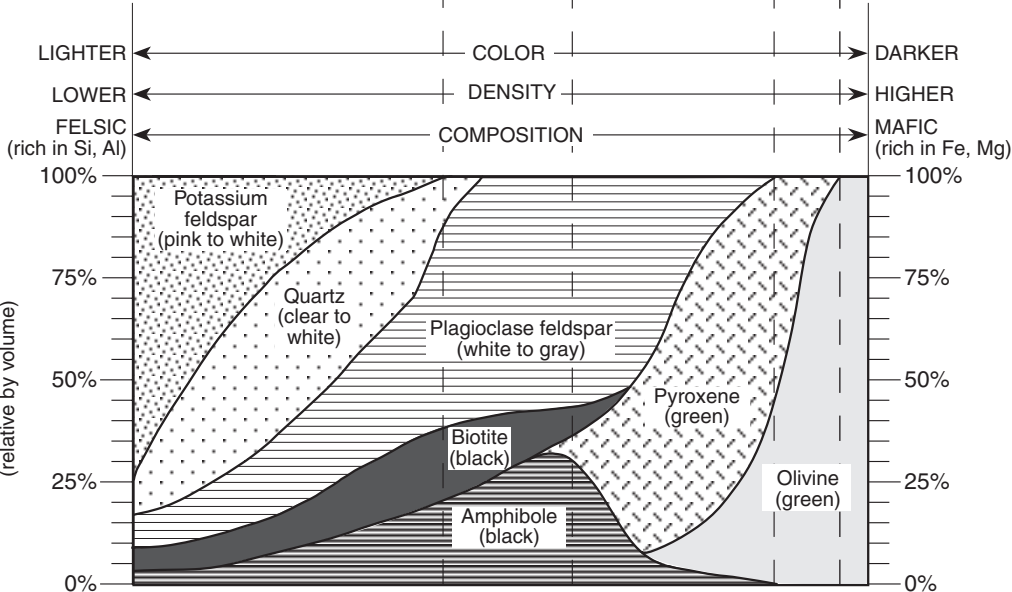
Scheme for Igneous Rock Identification

IGNEOUS ROCKS

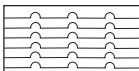
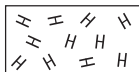
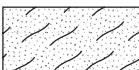
Scheme for Igneous Rock Identification							CRYSTAL SIZE	TEXTURE	
ENVIRONMENT OF FORMATION	EXTRUSIVE (Volcanic)	Obsidian (usually appears black)		Basaltic glass		non-crystalline		Glassy	Non-vesicular
		Pumice		Scoria					Vesicular (gas pockets)
		Vesicular rhyolite	Vesicular andesite	Vesicular basalt		less than 1 mm	Fine	Non-vesicular	
	Rhyolite	Andesite	Basalt						
			Diabase						
	INTRUSIVE (Plutonic)	Granite	Diorite	Gabbro	Peridotite	Dunite	1 mm to 10 mm		Coarse
Pegmatite							10 mm or larger		Very coarse

CHARACTERISTICS

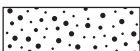
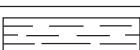
MINERAL COMPOSITION (relative by volume)

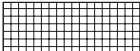
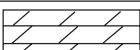
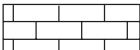


Scheme for Metamorphic Rock Identification

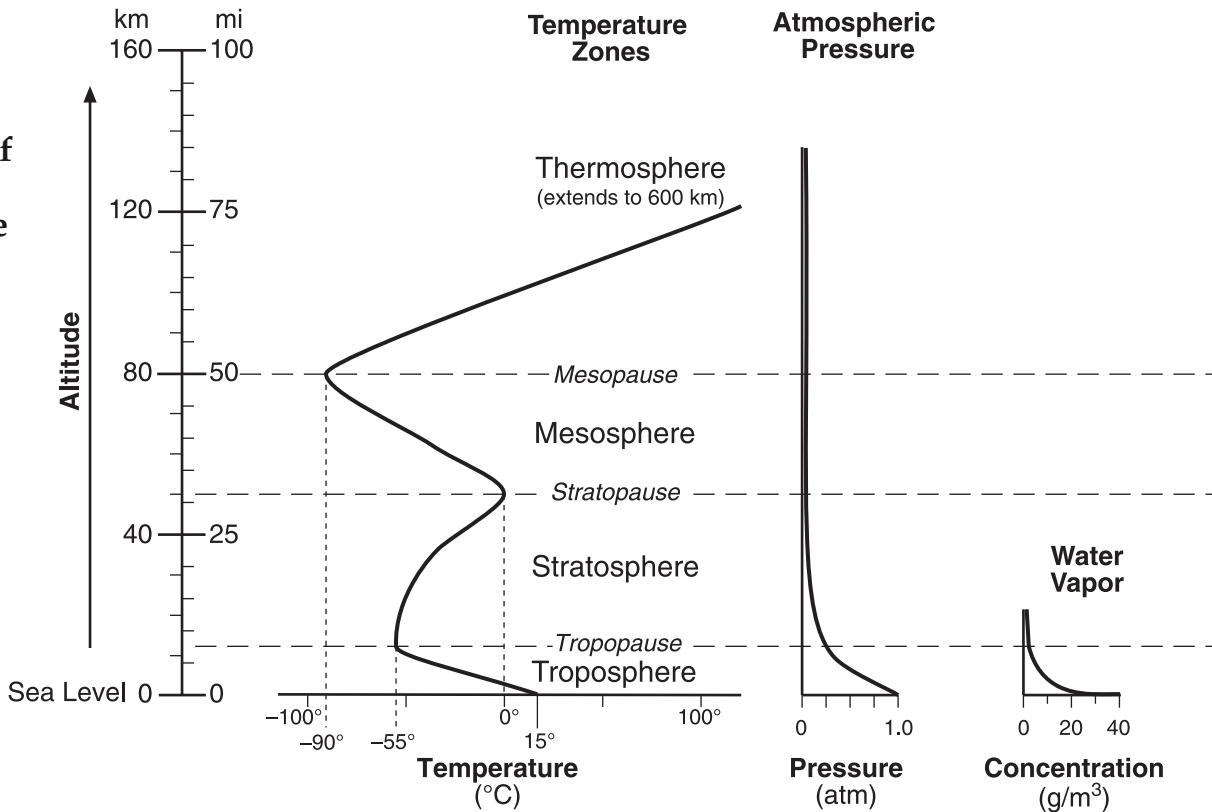
TEXTURE		GRAIN SIZE	COMPOSITION				TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL									
FOLIATED	MINERAL ALIGNMENT	Fine	MICA	QUARTZ	FELDSPAR	AMPHIBOLE	GARNET	PYROXENE	Regional (Heat and pressure increases) ↓	Low-grade metamorphism of shale	Slate								
		Fine to medium								Foliation surfaces shiny from microscopic mica crystals	Phyllite								
	BAND-ING	Medium to coarse								Platy mica crystals visible from metamorphism of clay or feldspars	Schist								
										High-grade metamorphism; mineral types segregated into bands	Gneiss								
NONFOLIATED		Fine	Carbon		Regional		Metamorphism of bituminous coal		Anthracite coal										
		Fine	Various minerals		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				Pebbles may be distorted or stretched		Metaconglomerate										

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 (0.006 to 0.2 cm)		Fine to coarse	Sandstone	
	Silt (0.0004 to 0.006 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	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	Rock salt	
		Gypsum		Rock gypsum	
		Dolomite		Dolostone	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	Limestone	
Bioclastic		Carbon	Compacted plant remains	Bituminous coal	

Selected Properties of Earth's Atmosphere



Solar System Data

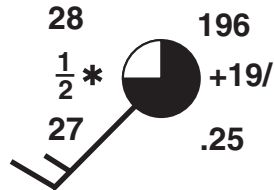
Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm ³)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

Specific Heats of Common Materials

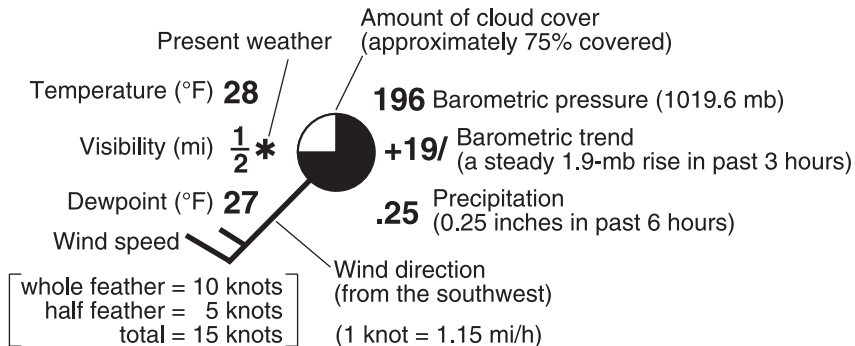
MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

Key to Weather Map Symbols

Station Model



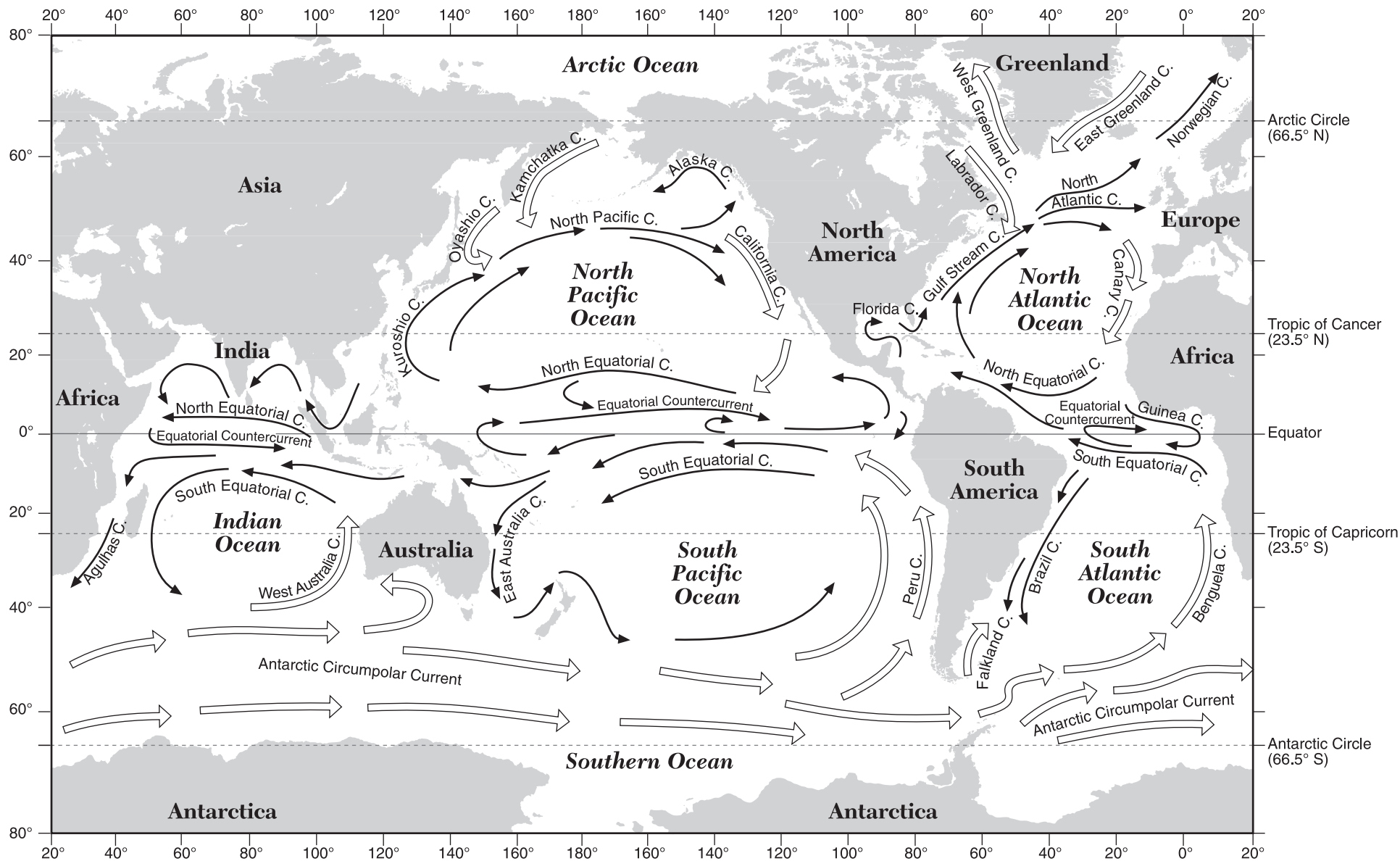
Station Model Explanation



Present Weather



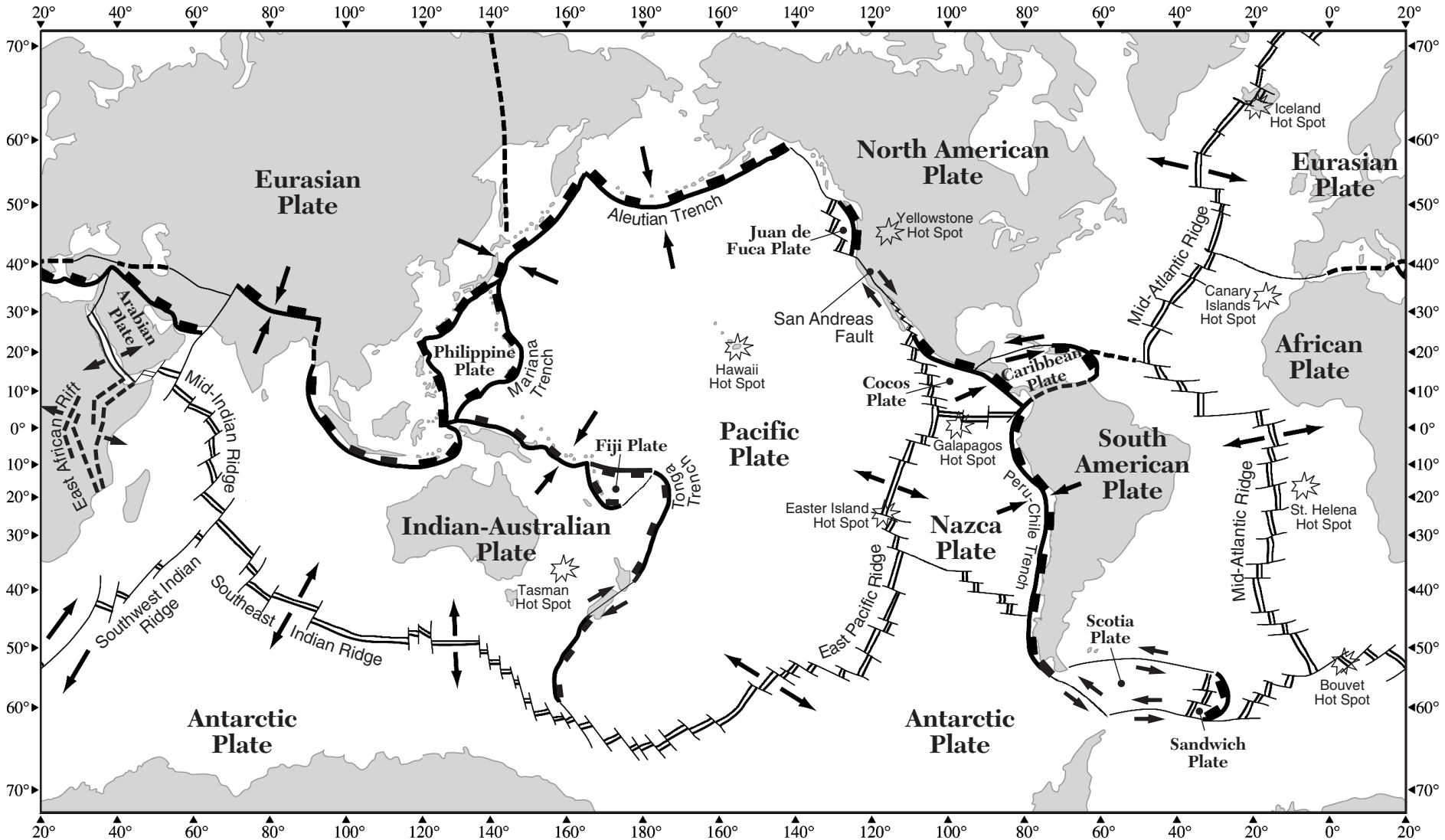
Surface Ocean Currents



NOTE: Not all surface ocean currents are shown.

Key	
	Warm currents
	Cool currents

Tectonic Plates



Key

→
Relative motion at plate boundary

↔
Transform plate boundary (transform fault)

↗↖
Divergent plate boundary (usually broken by transform faults along mid-ocean ridges)

↘↗
Convergent plate boundary (subduction zone)

Complex or uncertain plate boundary

★
Mantle hot spot

NOTE: Not all mantle hot spots, plates, and boundaries are shown.

Temperature

Fahrenheit
(°F)

Celsius
(°C)

Kelvin
(K)

