Earth Science Reference Tables

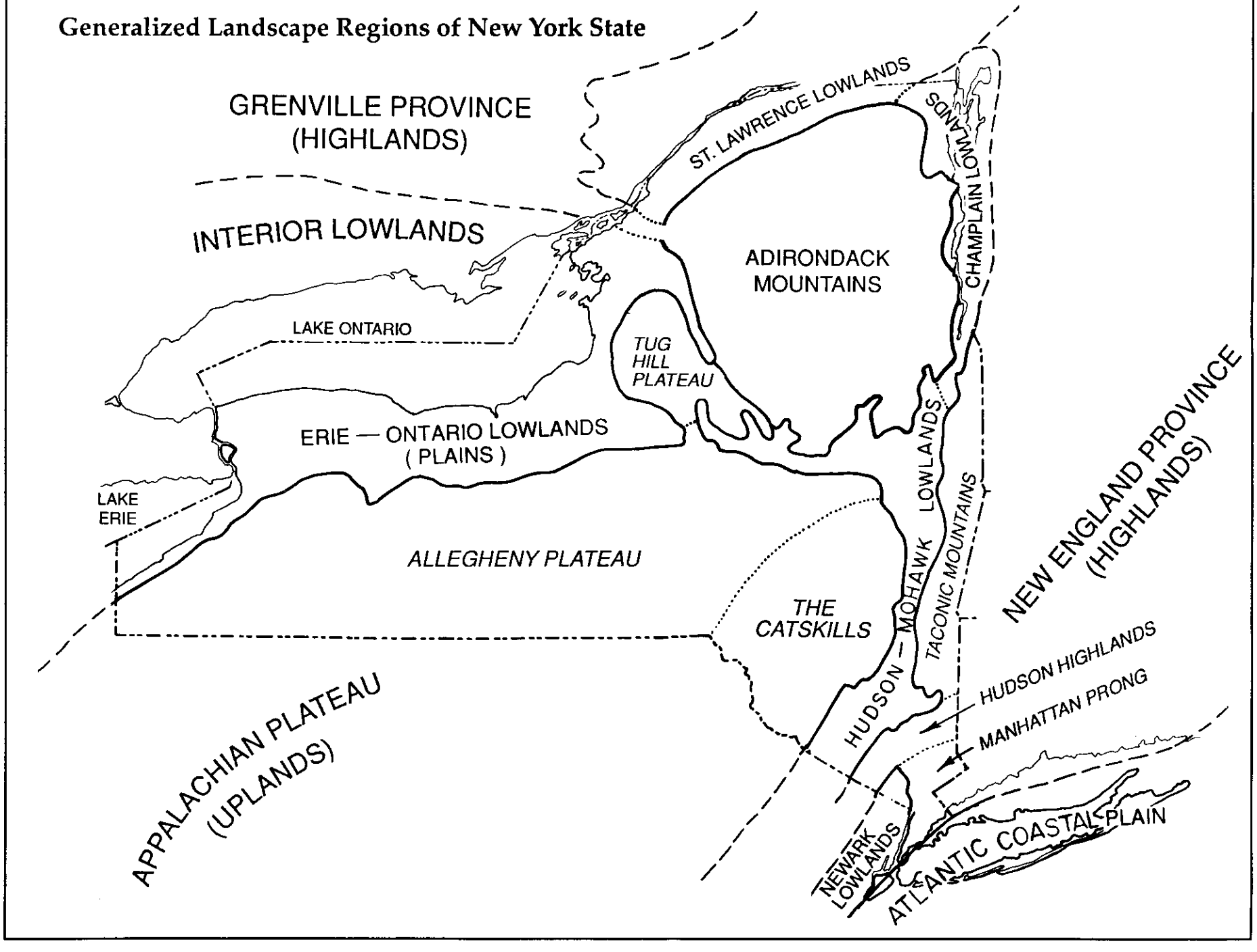
Contents

1994 EDITION

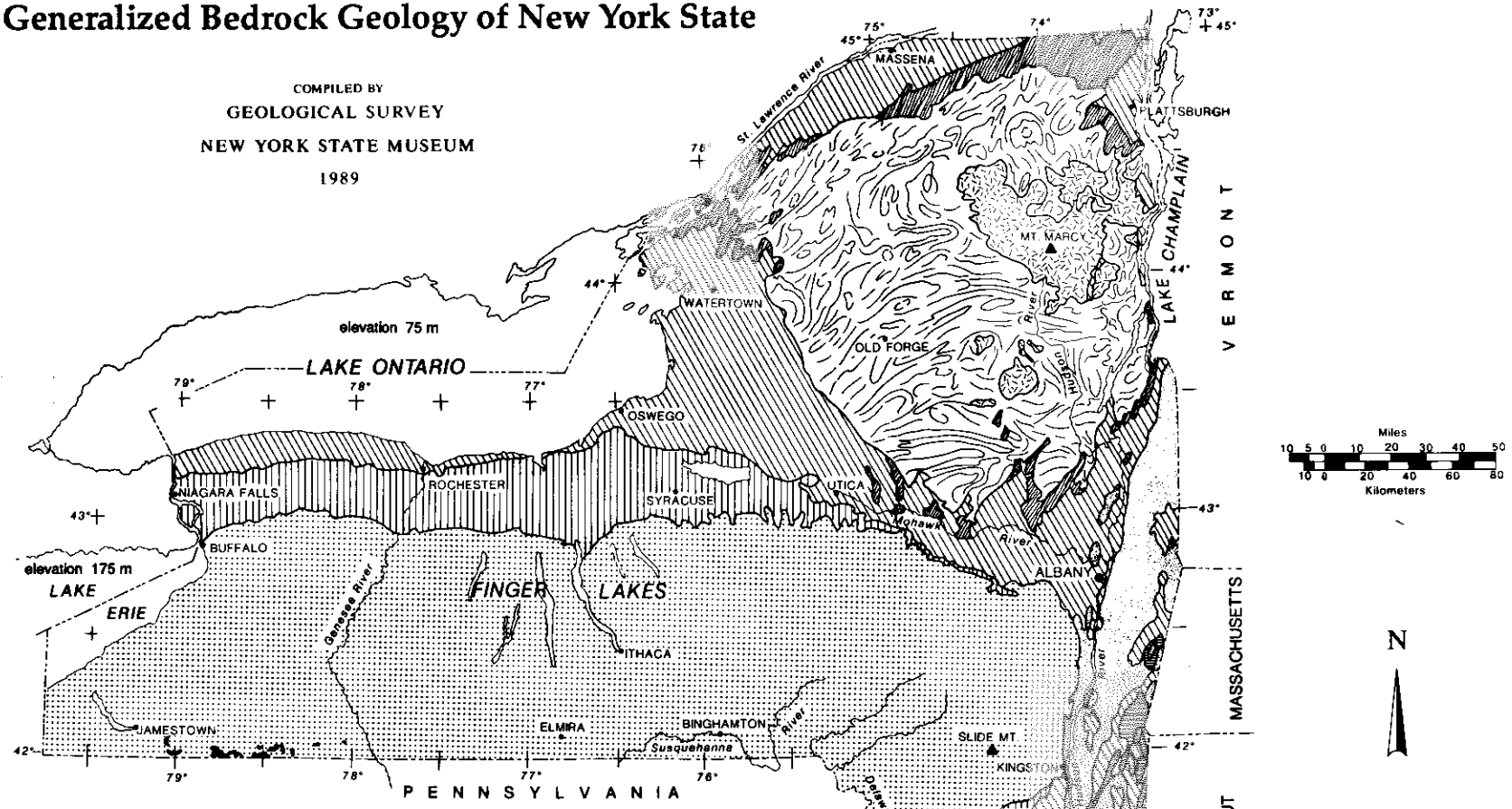
The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York 12234

This edition of the Earth Science Reference Tables should be used in the classroom beginning in the 1993–94 school year. The first examination for which these tables will be used is the June 1994 Regents Examination in Earth Science.

Generalized Landscape Regions of New York State



Generalized Bedrock Geology of New York State



GEOLOGICAL PERIODS in NEW YORK

- CRETACEOUS, TERTIARY, PLEISTOCENE (Epoch) unconsolidated gravels, sands, clays (not bedrock)
- LATE TRIASSIC AND EARLY JURASSIC conglomerates, red sandstones, red shales, diabase
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, conglomerates. *Silurian also contains salt, gypsum and hematite.*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, dolostones

Dominantly Sedimentary Origin

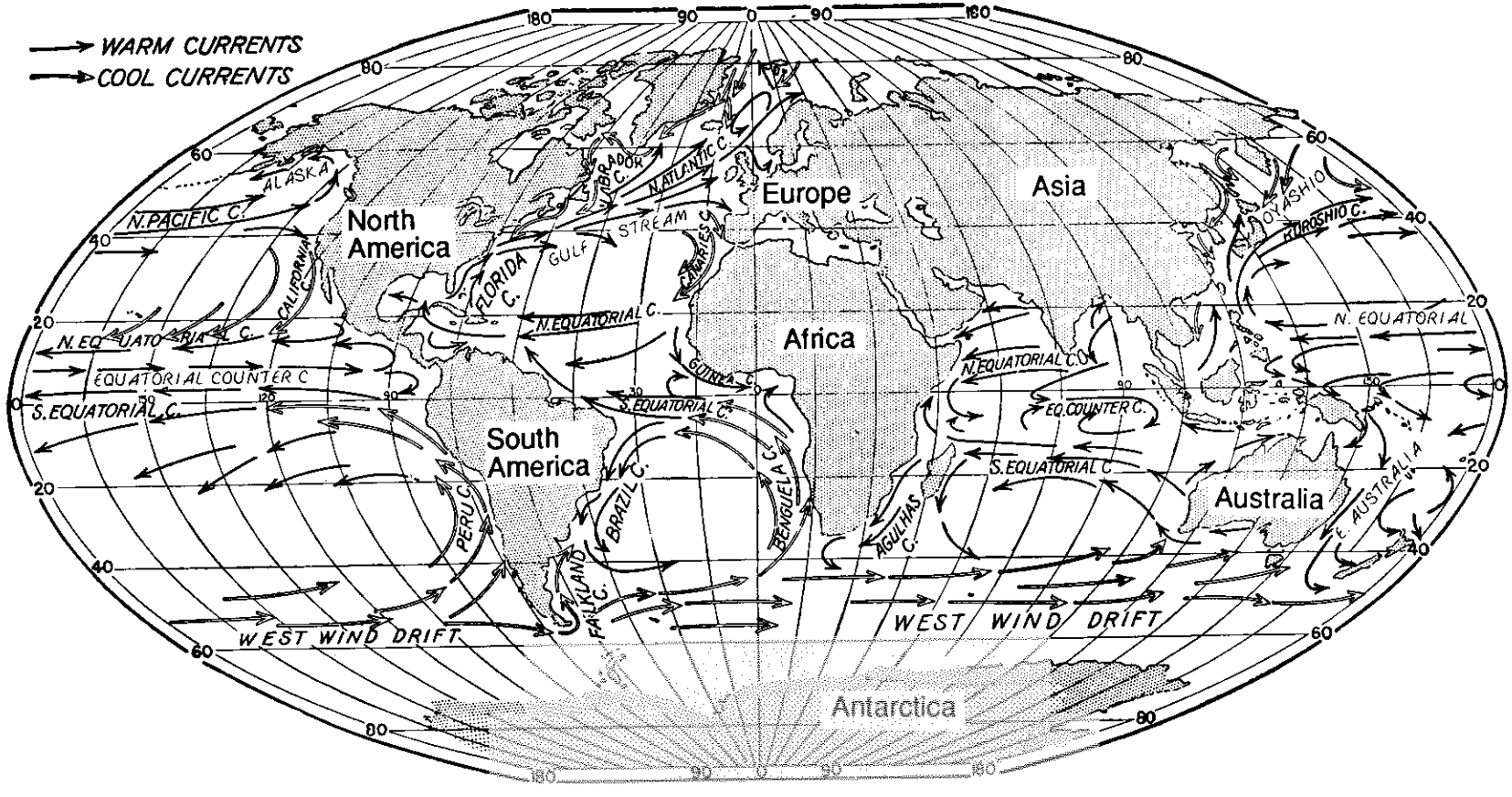
- CAMBRIAN and EARLY ORDOVICIAN sandstones, dolostones. *Moderately to intensely metamorphosed east of the Hudson River.*
- CAMBRIAN & ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, schists. *Intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex.*
- *TACONIC SEQUENCE* sandstones, shales, slates. *Slightly to intensely metamorphosed rocks of* CAMBRIAN and EARLY ORDOVICIAN *ages.*

Dominantly Metamorphosed Rocks

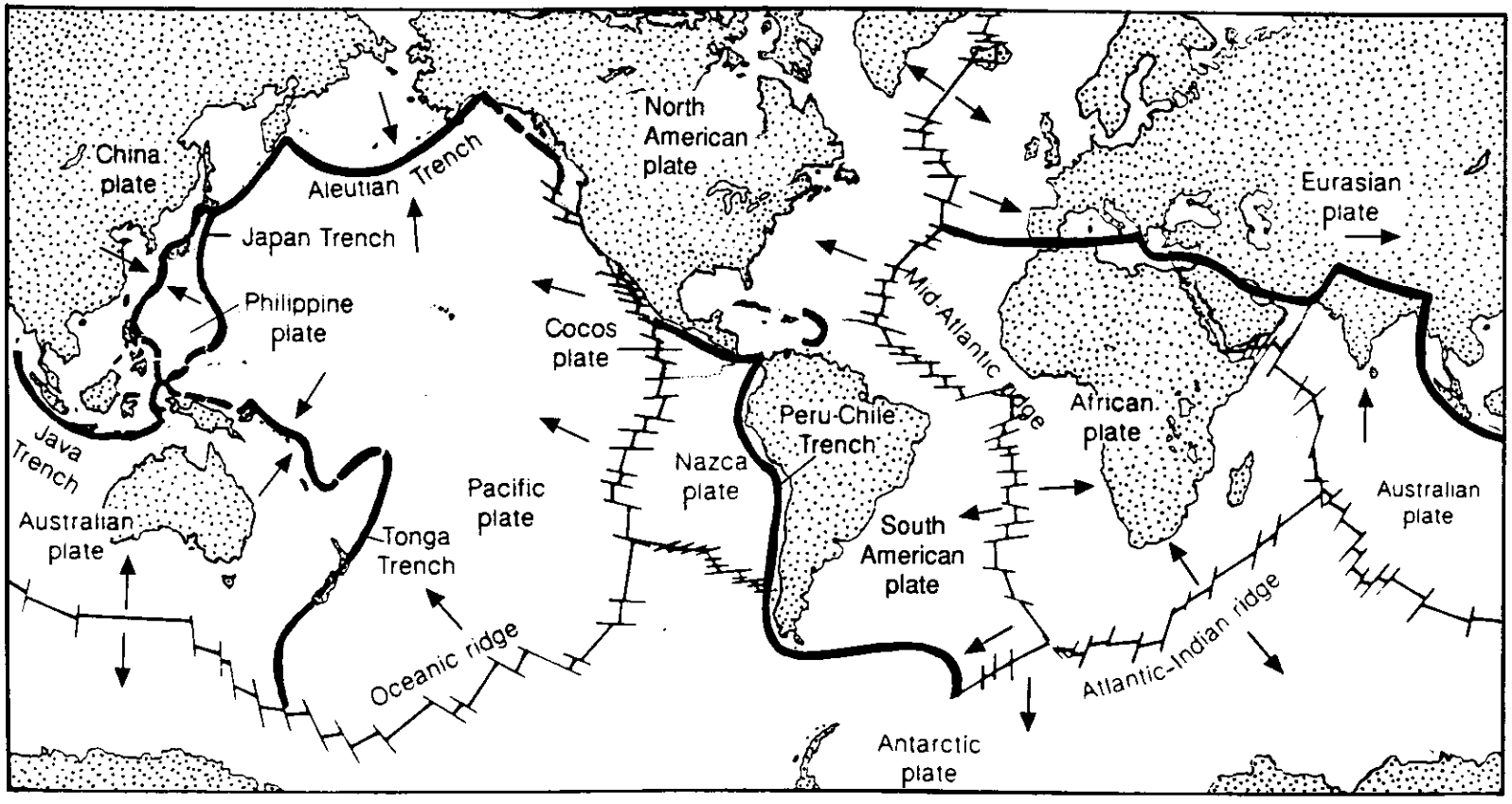
- MIDDLE PROTEROZOIC gneisses, quartzites, marbles. *Lines are generalized structure trends.*
- MIDDLE PROTEROZOIC anorthositic rocks

Intensely Metamorphosed Rocks (regional metamorphism about 1,000 m.y.a.)

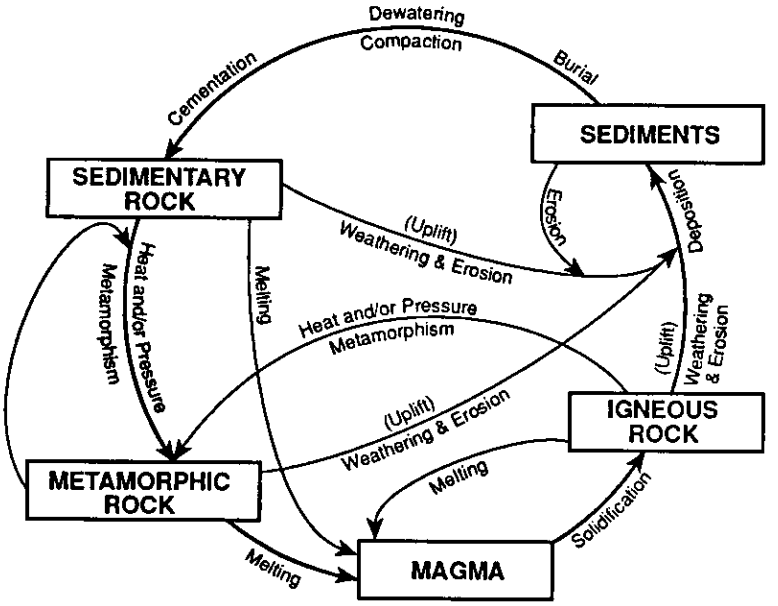
Surface Ocean Currents



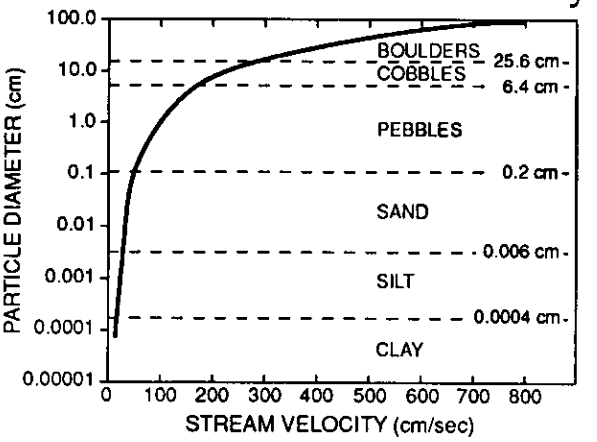
Tectonic Plates



Rock Cycle in Earth's Crust



Relationship of Transported Particle Size to Water Velocity*

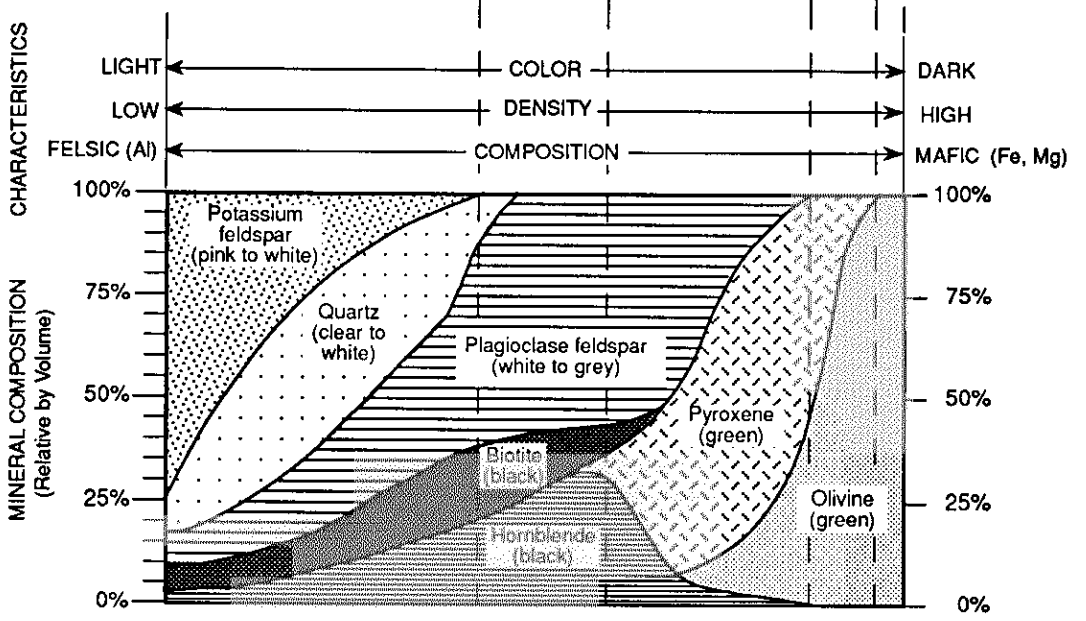


*This generalized graph shows the water velocity needed to maintain, but not start movement. Variations occur due to differences in particle density and shape.

Scheme for Igneous Rock Identification

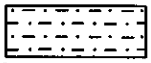
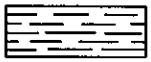
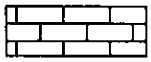
ENVIRONMENT OF FORMATION							GRAIN SIZE	TEXTURE
INTRUSIVE (Plutonic)	Granite	Diorite	Gabbro	Perid-otite	Dunite		1 mm or larger	Coarse
EXTRUSIVE (Volcanic)	Rhyolite	Andesite	Basalt Scoria	Rare	Rare		less than 1 mm	Fine
EXTRUSIVE (Volcanic)	Pumice *Obsidian	*Obsidian	Basalt Glass	Rare	Rare		Non-crystalline	Glassy

* Obsidian may appear black.

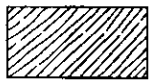
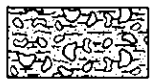
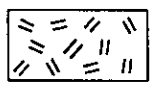


Note: The intrusive rocks can also occur as exceptionally coarse-grained rock, Pegmatite.

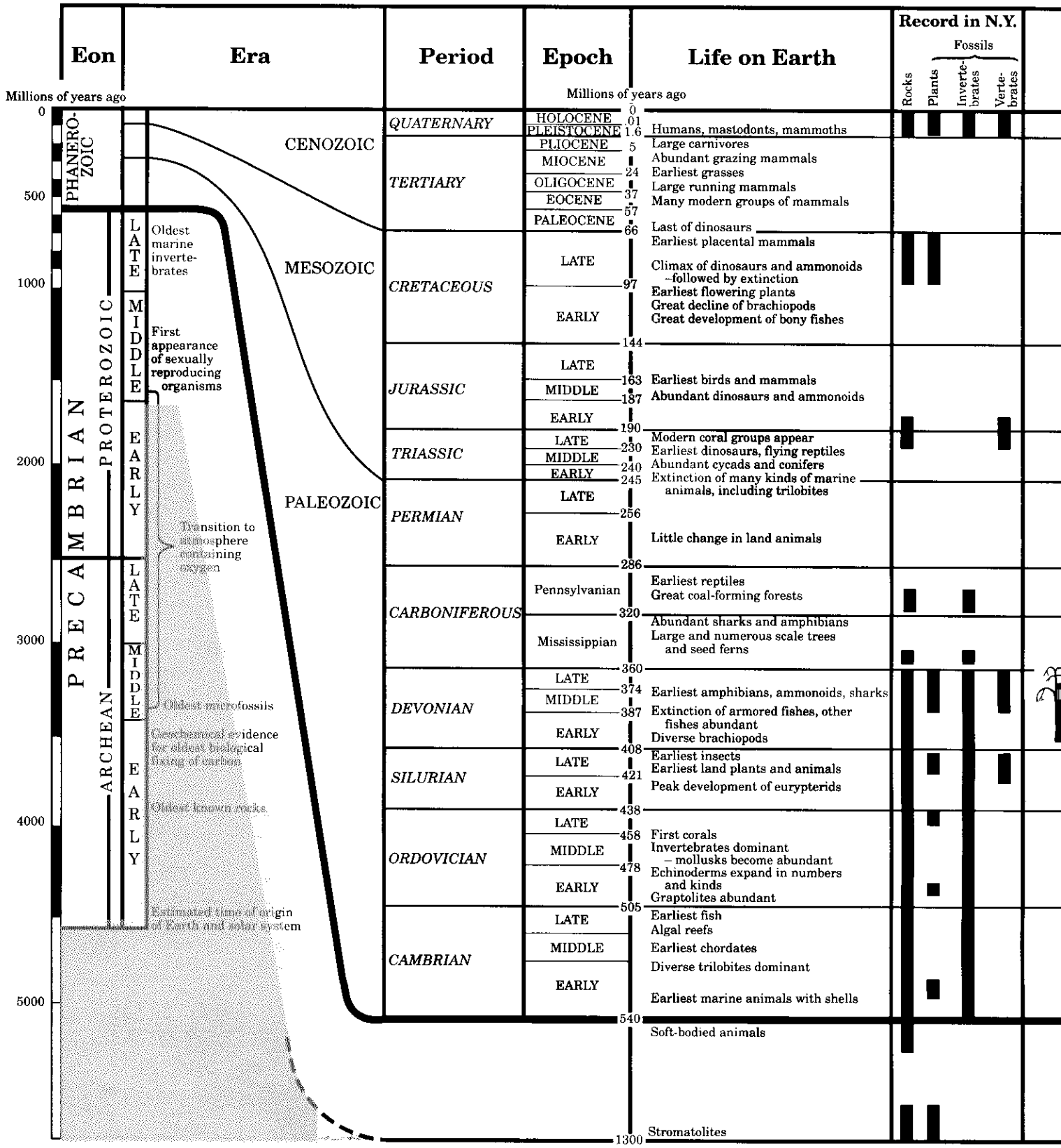
Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Clastic (fragmental)	Mixed, silt to boulders (larger than 0.001 cm)	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 0.0006 cm)		Compact; may split easily	Shale	
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Nonclastic	Coarse to fine	Calcite	Crystals from chemical precipitates and evaporites	Chemical Limestone	
	Varied	Halite		Rock Salt	
	Varied	Gypsum		Rock Gypsum	
	Varied	Dolomite		Dolostone	
	Microscopic to coarse	Calcite	Cemented shells, shell fragments, and skeletal remains	Fossil Limestone	
	Varied	Carbon	Black and nonporous	Bituminous Coal	

Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	Slaty	Fine	CHLORITE, MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional	Low-grade metamorphism of shale	Slate	
	Schistose	Medium to coarse			Medium-grade metamorphism; Mica crystals visible from metamorphism of feldspars and clay minerals	Schist	
	Gneissic	Coarse		(Heat and pressure increase with depth, folding, and faulting)	High-grade metamorphism; Mica has changed to feldspar	Gneiss	
NONFOLIATED		Fine	Carbonaceous		Metamorphism of plant remains and bituminous coal	Anthracite Coal	
		Coarse	Depends on conglomerate composition		Pebbles may be distorted or stretched; Often breaks through pebbles	Meta-conglomerate	
		Fine to coarse	Quartz	Thermal (including contact) or Regional	Metamorphism of sandstone	Quartzite	
			Calcite, Dolomite		Metamorphism of limestone or dolostone	Marble	
		Fine	Quartz, Plagioclase	Contact	Metamorphism of various rocks by contact with magma or lava	Hornfels	

GEOLOGIC HISTORY OF NEW



YORK STATE AT A GLANCE

Important Fossils of New York	Tectonic Events Affecting Northeast North America	Important Geologic Events in New York	Inferred Position of Earth's Landmasses
CONDOR, MASTODONT, FIG-LIKE LEAF	Passive Margin	Advance and retreat of last continental ice Uplift of Adirondack region	TERTIARY 59 million years ago
	Passive Margin	Sandstones and shales underlying Long Island and Staten Island deposited on margin of Atlantic Ocean Development of passive continental margin Kimberlite and lamprophere dikes	CRETACEOUS 119 million years ago
COELOPHYSIS	Passive Margin	Atlantic Ocean continues to widen Initial opening of Atlantic Ocean	
	Rifting	Intrusion of Palisades sill Rifting	TRIASSIC 232 million years ago
CLAM		Massive erosion of Paleozoic rocks Appalachian (Alleghanian) Orogeny caused by collision of North America and Africa along transform margin	
BRACHIOPOD, AMMONOID, PLACODERM FISH, EURYPTERID	Transform Collision	Catskill Delta forms Erosion of Acadian Mountains Acadian Orogeny caused by collision of North America and Avalon and closing of remaining part of Iapetus Ocean Evaporite basins; salt and gypsum deposited	PENNSYLVANIAN 306 million years ago
CORAL HEAD, GRAPTOLITE	Transform Collision	Erosion of Taconic Mountains; Queenston Delta forms Taconian Orogeny caused by closing of western part of Iapetus Ocean and collision between North America and volcanic island arc	DEVONIAN/MISSISSIPPIAN 363 million years ago
TRILOBITE	Subduction, Continental Collision	Iapetus passive margin forms	ORDOVICIAN 458 million years ago
STROMATOLITES	Rifting, Passive Margin	Rifting and initial opening of Iapetus Ocean Erosion of Grenville Mountains Grenville Orogeny: Ancestral Adirondack Mtns. and Hudson Highlands formed Subduction and volcanism Sedimentation, volcanism	

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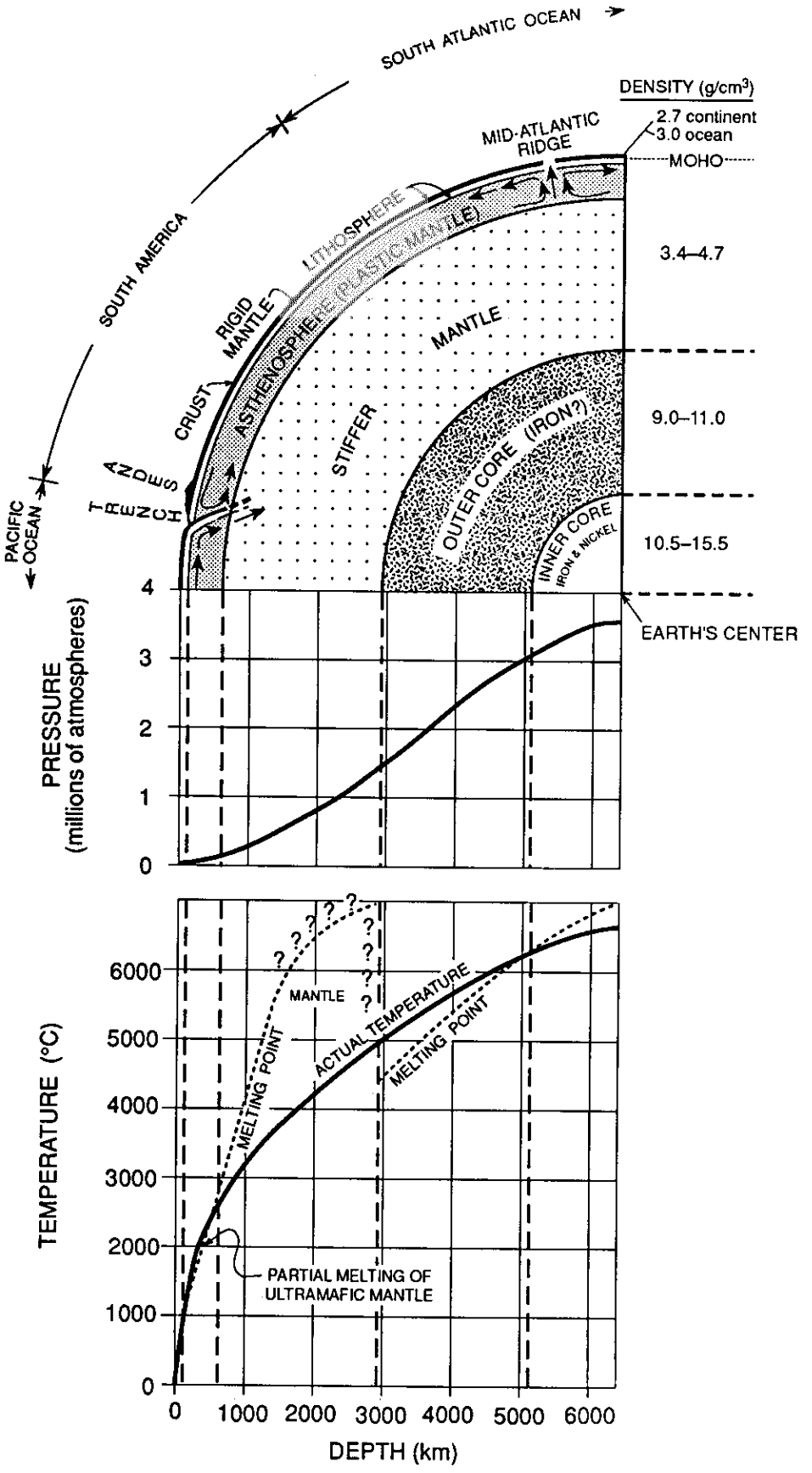
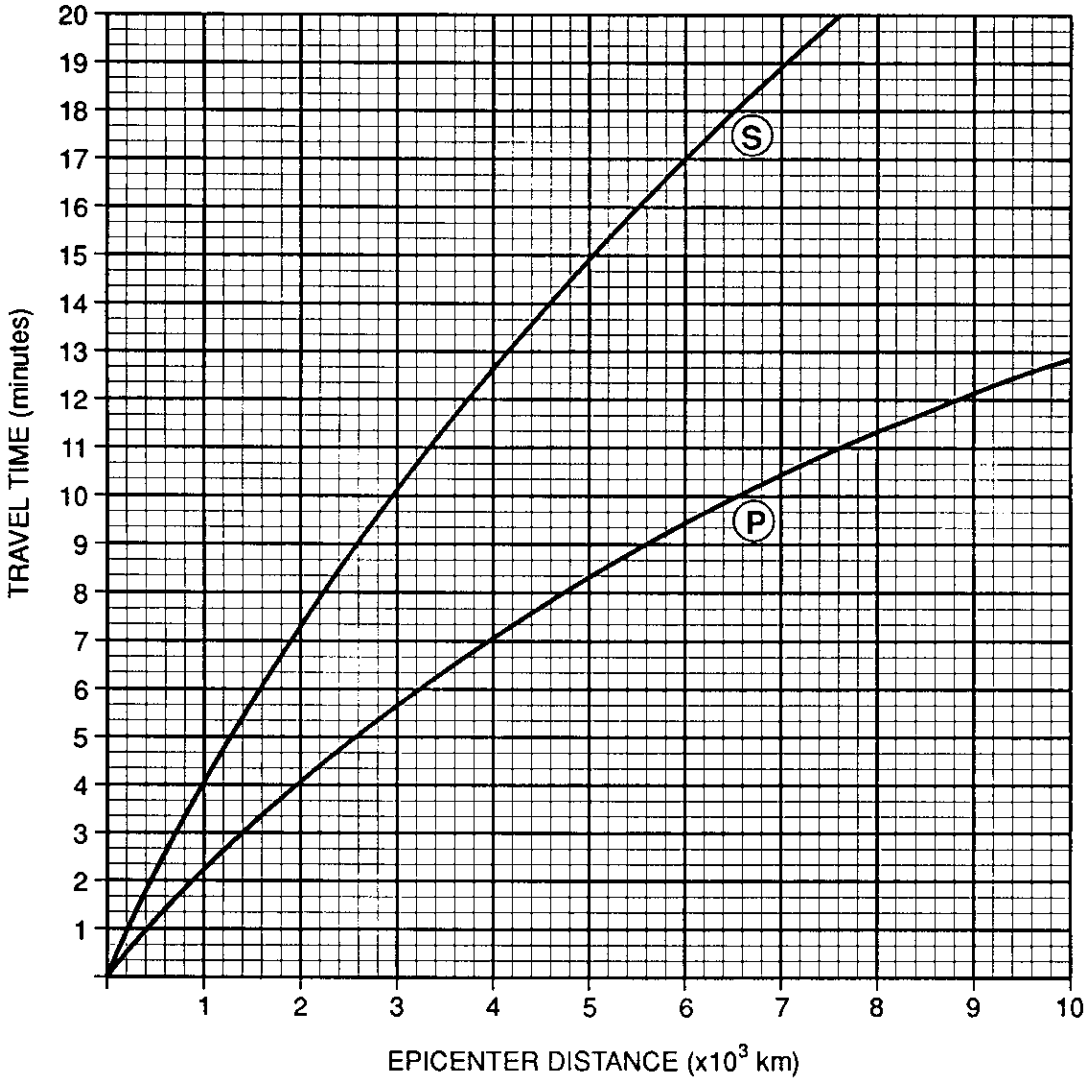
Inferred Properties of Earth's Interior



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	21
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
Hydrogen (H)			66	

Earthquake P-wave and S-wave Travel Time



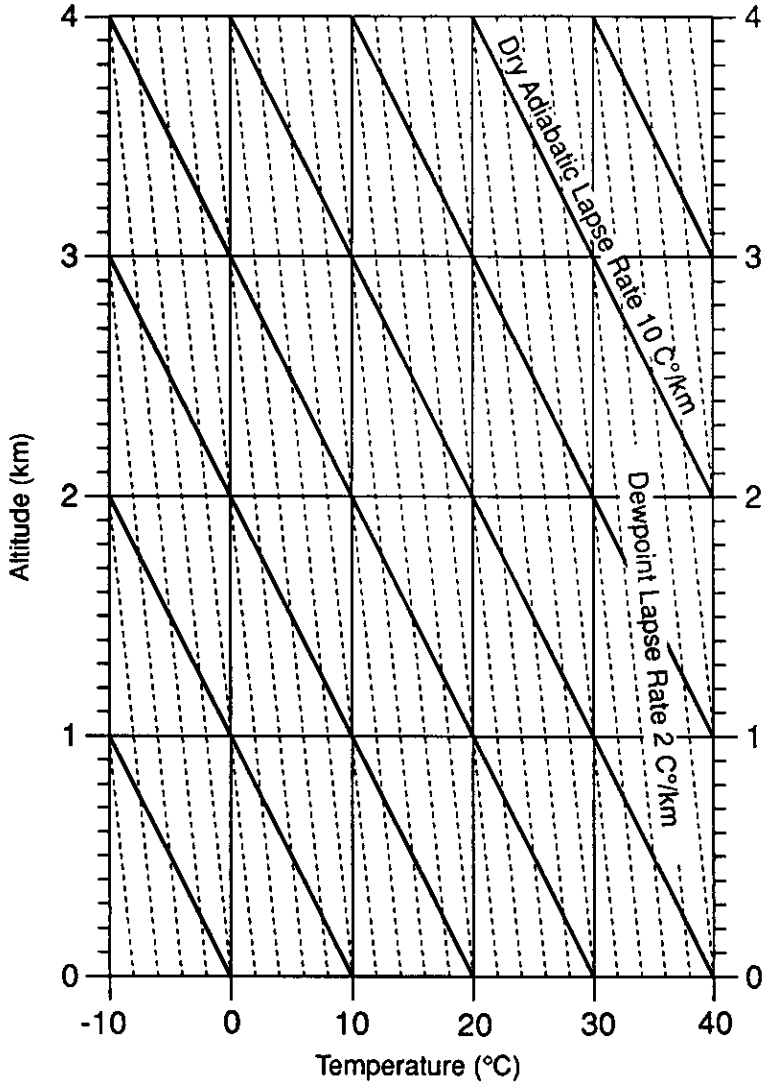
Dewpoint Temperatures

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

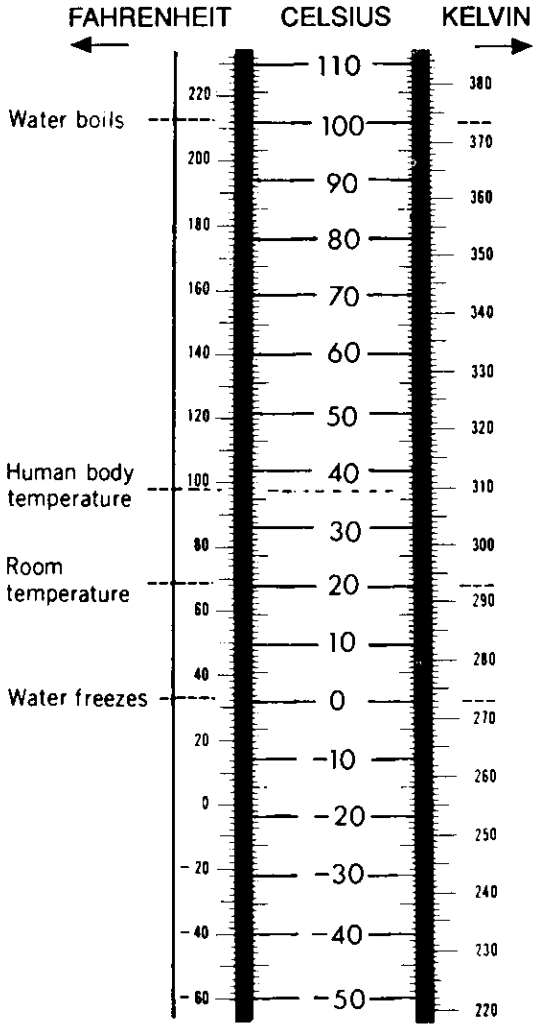
Relative Humidity (%)

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

Lapse Rate

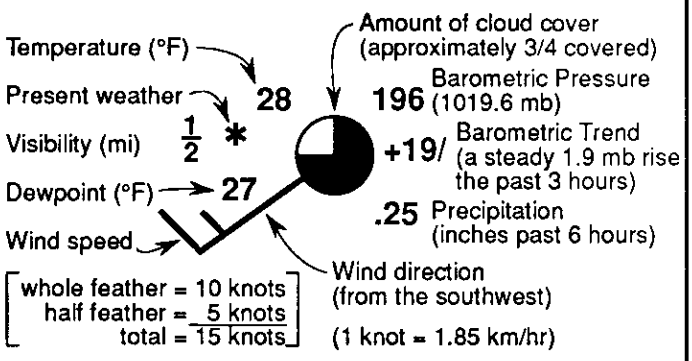


Temperature

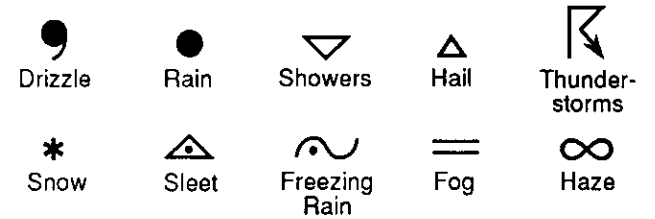


Weather Map Information

STATION MODEL



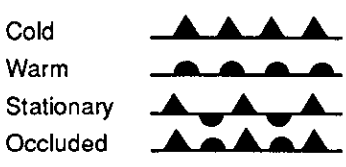
PRESENT WEATHER SYMBOLS



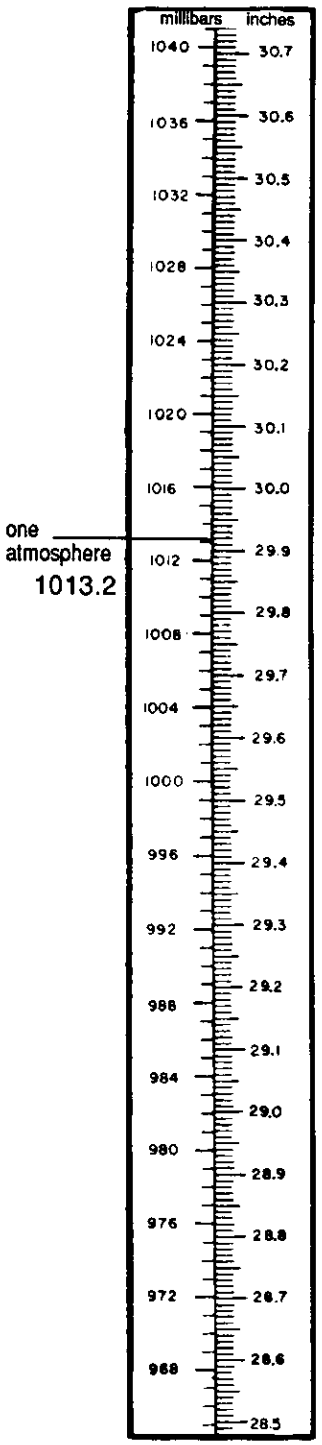
AIRMASSES

cP	Continental polar
cT	Continental tropical
mT	Maritime tropical
mP	Maritime polar

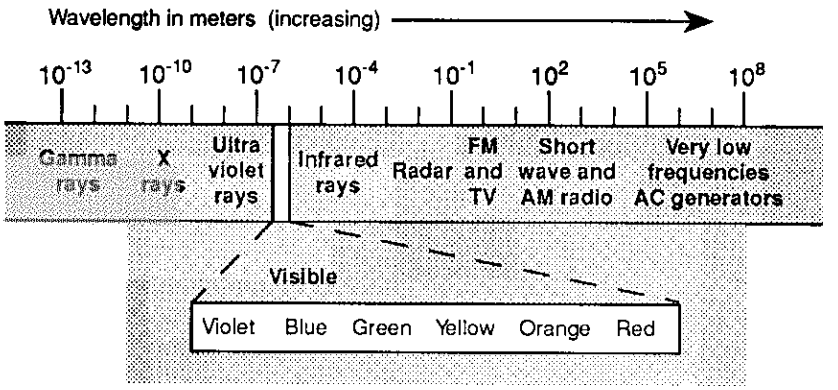
FRONT SYMBOLS



Pressure



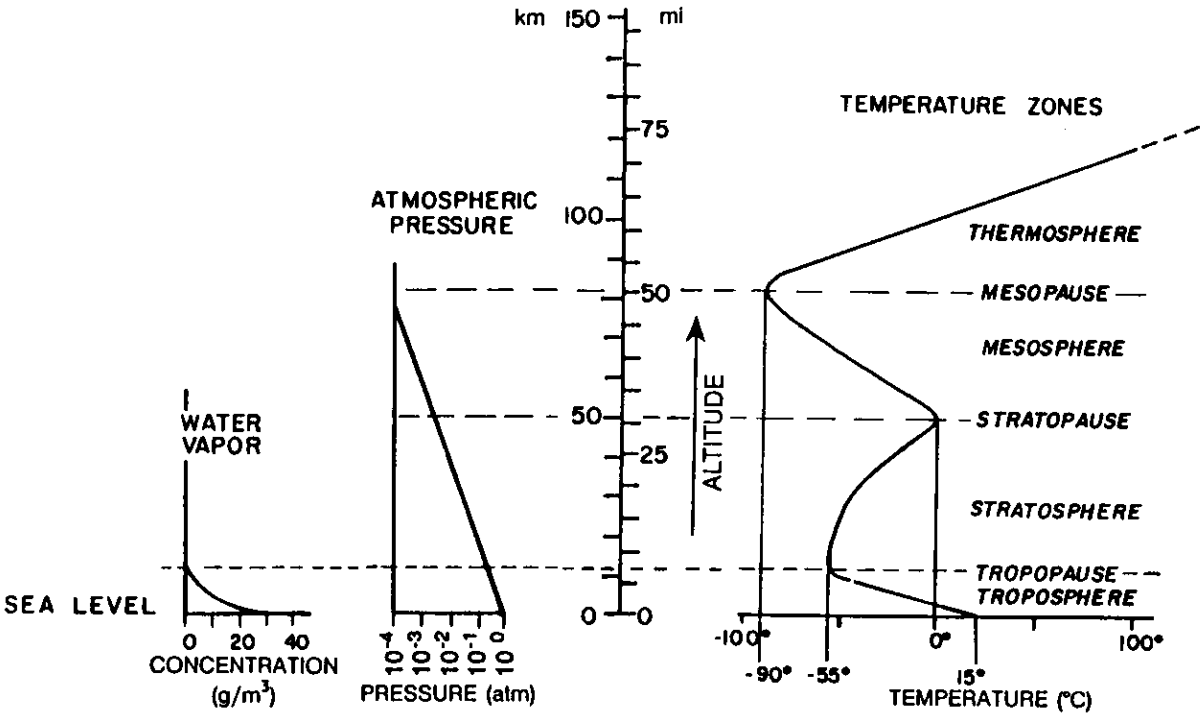
Electromagnetic Spectrum



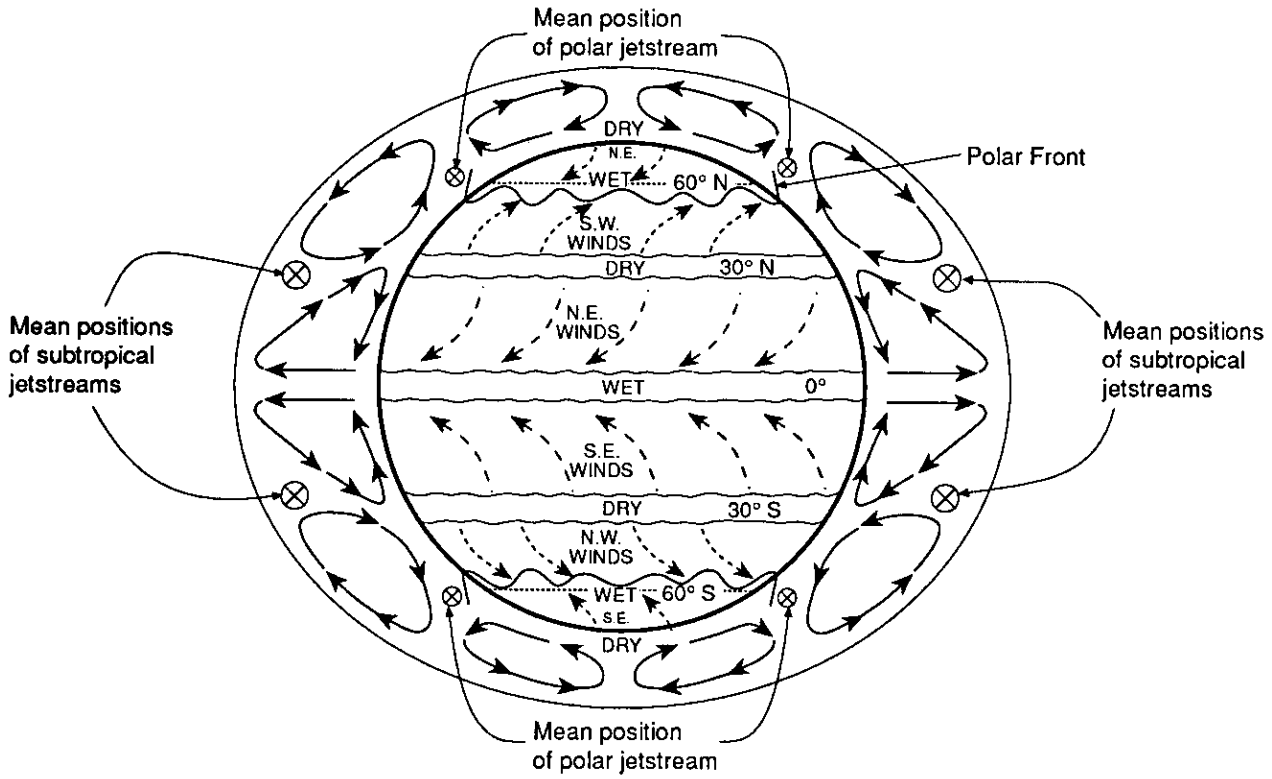
Solar System Data

Planet	Mean Distance from Sun (millions of km)	Period of Revolution	Period of Rotation	Eccentricity of Orbit	Equatorial Diameter (km)	Density (g/cm^3)
MERCURY	57.9	88 days	59 days	0.206	4,880	5.4
VENUS	108.2	224.7 days	243 days	0.007	12,104	5.2
EARTH	149.6	365.26 days	23 hours 56 min 4 sec	0.017	12,756	5.5
MARS	227.9	687 days	24 hours 37 min 23 sec	0.093	6,787	3.9
JUPITER	778.3	11.86 years	9 hours 50 min 30 sec	0.048	142,800	1.3
SATURN	1,427	29.46 years	10 hours 14 min	0.056	120,000	0.7
URANUS	2,869	84.0 years	11 hours	0.047	51,800	1.2
NEPTUNE	4,496	164.8 years	16 hours	0.009	49,500	1.7
PLUTO	5,900	247.7 years	6 days 9 hours	0.250	2,300	2.0

Selected Properties of Earth's Atmosphere



Planetary Wind and Moisture Belts in the Troposphere



The drawing 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.

Equations and Proportions

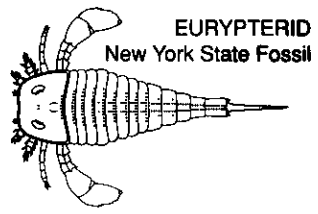
Equations

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	$\text{gradient} = \frac{\text{change in field value}}{\text{change in distance}}$
Rate of change	$\text{rate of change} = \frac{\text{change in field value}}{\text{change in time}}$
Circumference of a circle	$C = 2\pi r$
Eratosthenes' method to determine Earth's circumference	$\frac{\angle a}{360^\circ} = \frac{s}{C}$
Volume of a rectangular solid	$V = \ell wh$
Density of a substance	$D = \frac{m}{V}$
Latent heat	solid $\longleftrightarrow$ liquid $Q = mH_f$; liquid $\longleftrightarrow$ gas $Q = mH_v$
Heat energy lost or gained	$Q = m\,\Delta T C_p$

C_p = specific heat
C = circumference
d = distance
D = density
F = force
h = height
H_f = heat of fusion
H_v = heat of vaporization
$\angle a$ = shadow angle
ℓ = length
s = distance on surface
m = mass
Q = amount of heat
r = radius
ΔT = change in temperature
V = volume
w = width
Note: $\pi \approx 3.14$

Proportions

Kepler's harmonic law of planetary motion	$(\text{period of revolution})^2 \propto (\text{mean radius of orbit})^3$
Universal law of gravitation	$\text{force} \propto \frac{\text{mass}_1 \times \text{mass}_2}{(\text{distance between their centers})^2}$ $\left(F \propto \frac{m_1\, m_2}{d^2}\right)$



EURYPTERID
New York State Fossil

Physical Constants

Properties of Water

Latent heat of fusion (H_f)	80 cal/g
Latent heat of vaporization (H_v)	540 cal/g
Density (D) at 3.98°C	1.00 g/mL

Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$C^{14} \rightarrow N^{14}$	5.7×10^3
Potassium-40	$K^{40} \rightarrow Ar^{40}$, $K^{40} \rightarrow Ca^{40}$	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 (C_p) (cal/g•C°)
Water (solid)	0.5
Water (liquid)	1.0
Water (gas)	0.5
Dry air	0.24
Basalt	0.20
Granite	0.19
Iron	0.11
Copper	0.09
Lead	0.03

Astronomy Measurements

MEASUREMENT	EARTH	SUN	MOON
Mass (m)	5.98×10^{24} kg	1.99×10^{30} kg	7.35×10^{22} kg
Radius (r)	6.37×10^3 km	6.96×10^5 km	1.74×10^3 km
Average density (D)	5.52 g/cm^3	1.42 g/cm^3	3.34 g/cm^3

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