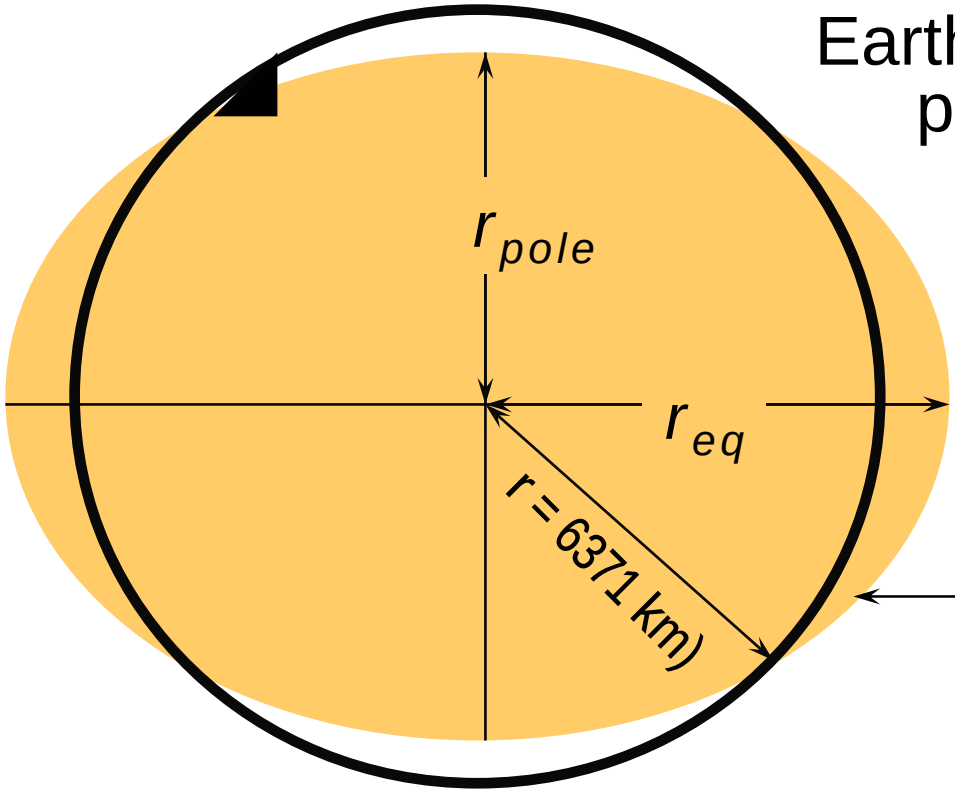
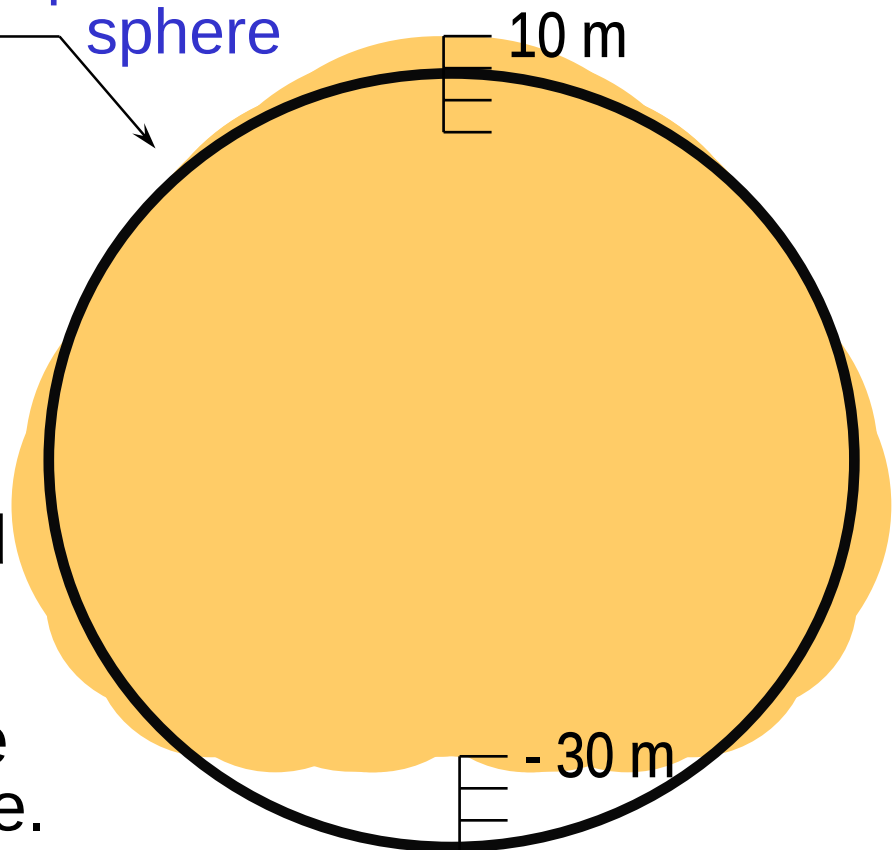


Earth has an equatorial bulge and polar flattening, with equatorial radius (r_{eq}) ~21 km greater than the polar radius (r_{pole}). The radius (r) of an equivalent sphere is 6,371 km.

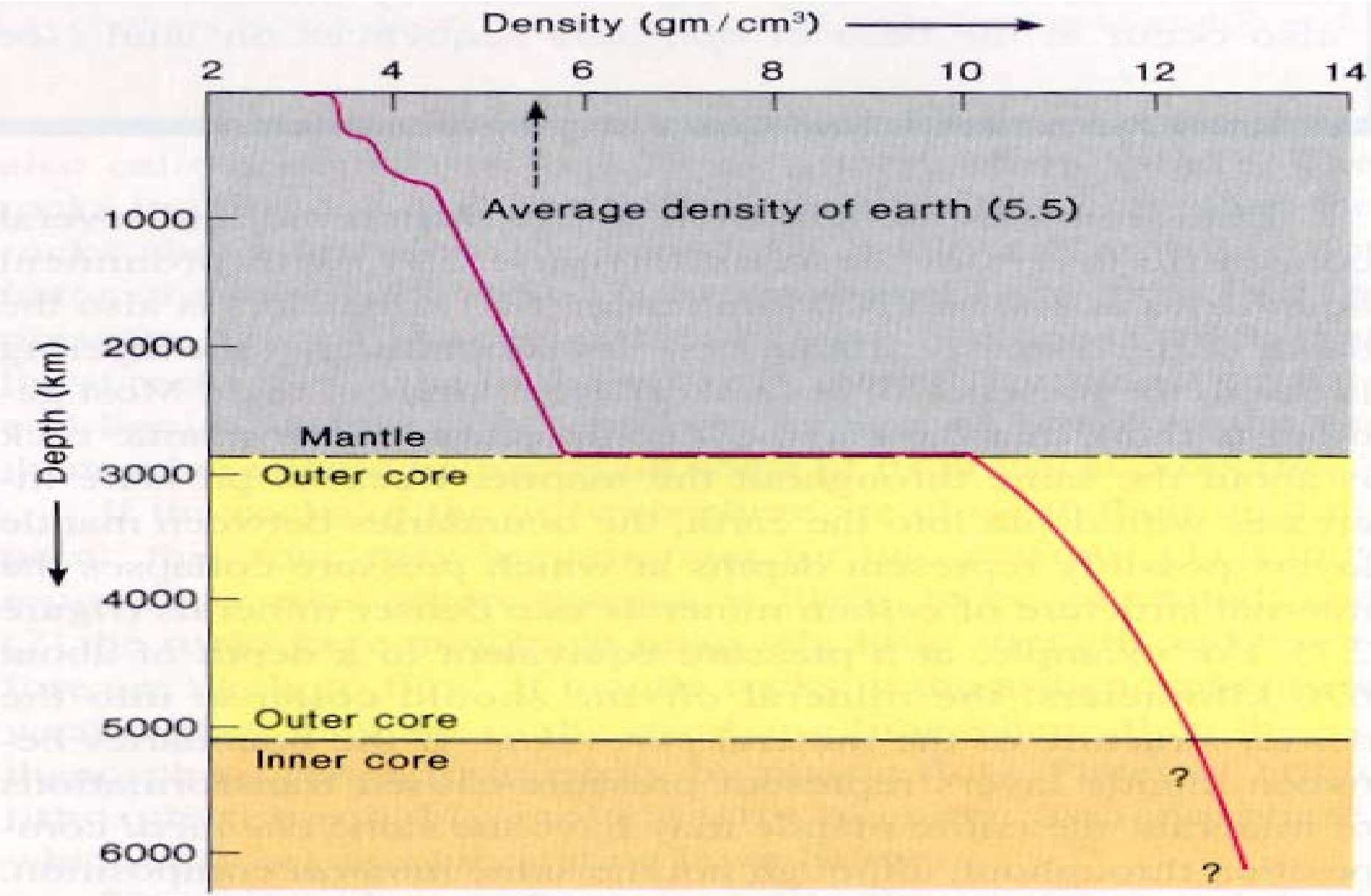
Equivalent sphere

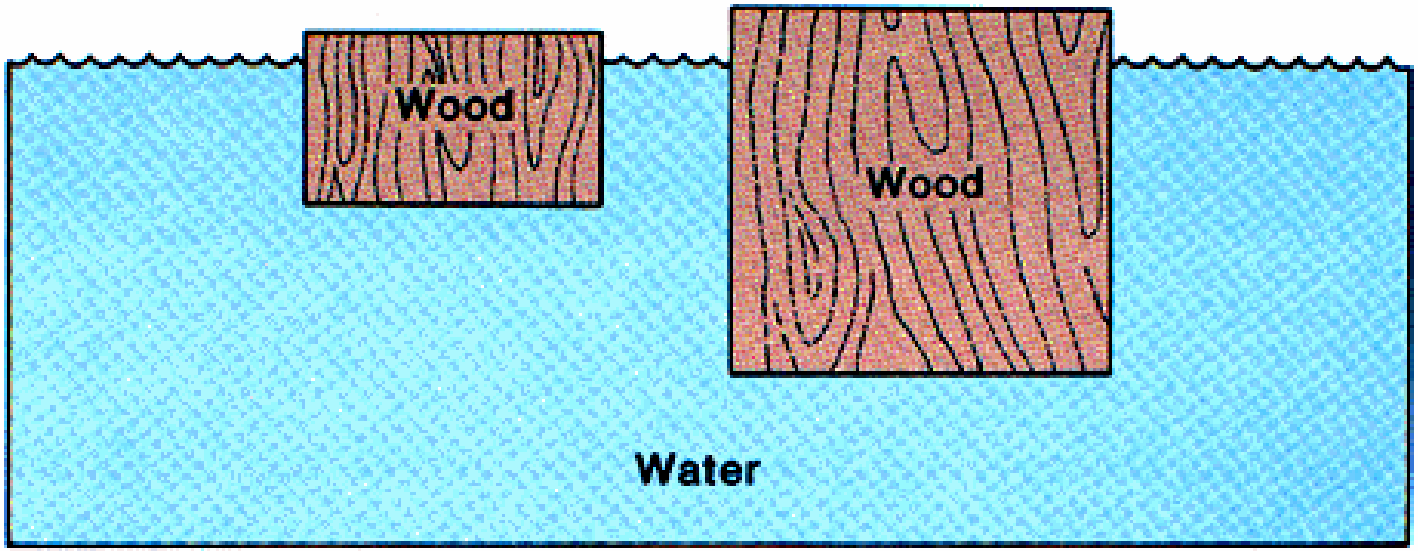


Based on satellite mapping, the earth is now known to be truly pear-shaped, in that, added to facts of earth's equatorial bulge and polar flattening, the south pole is ~40 m closer to the earth's center than the north pole.

Whole earth density is twice the average density of surface ro

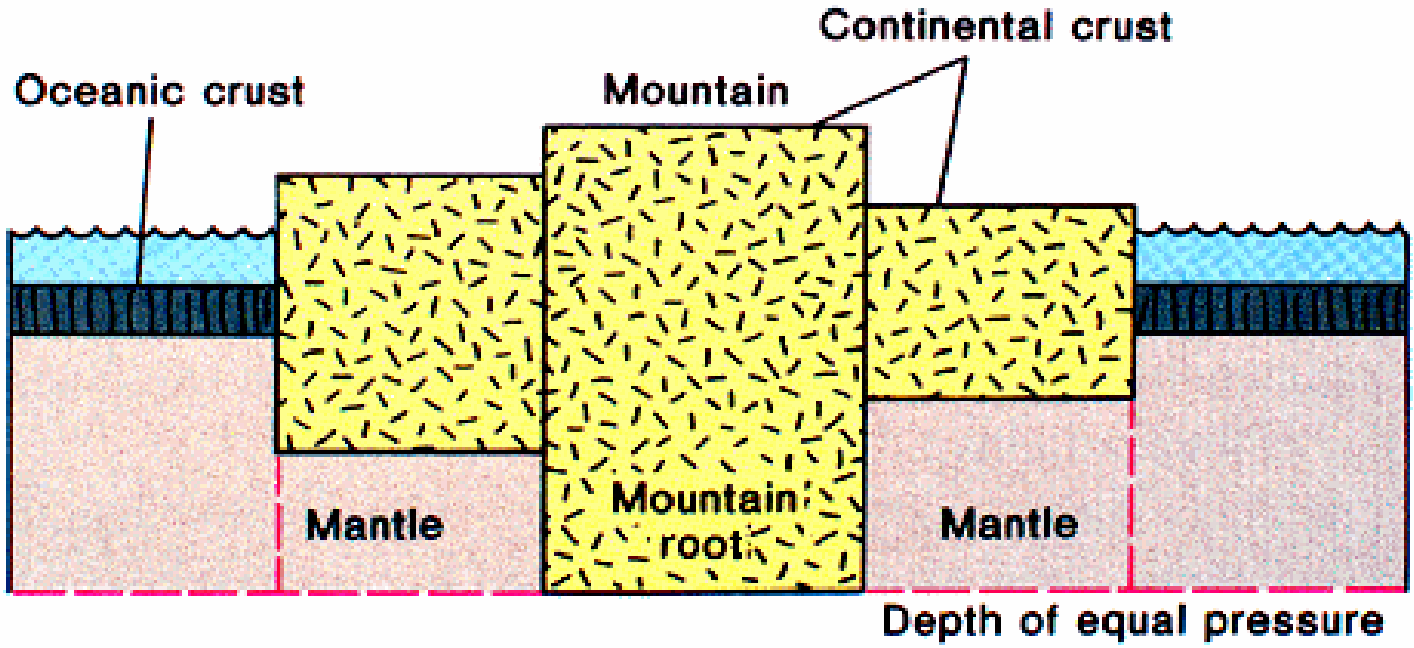
i.e., density must increase with depths inside the earth.

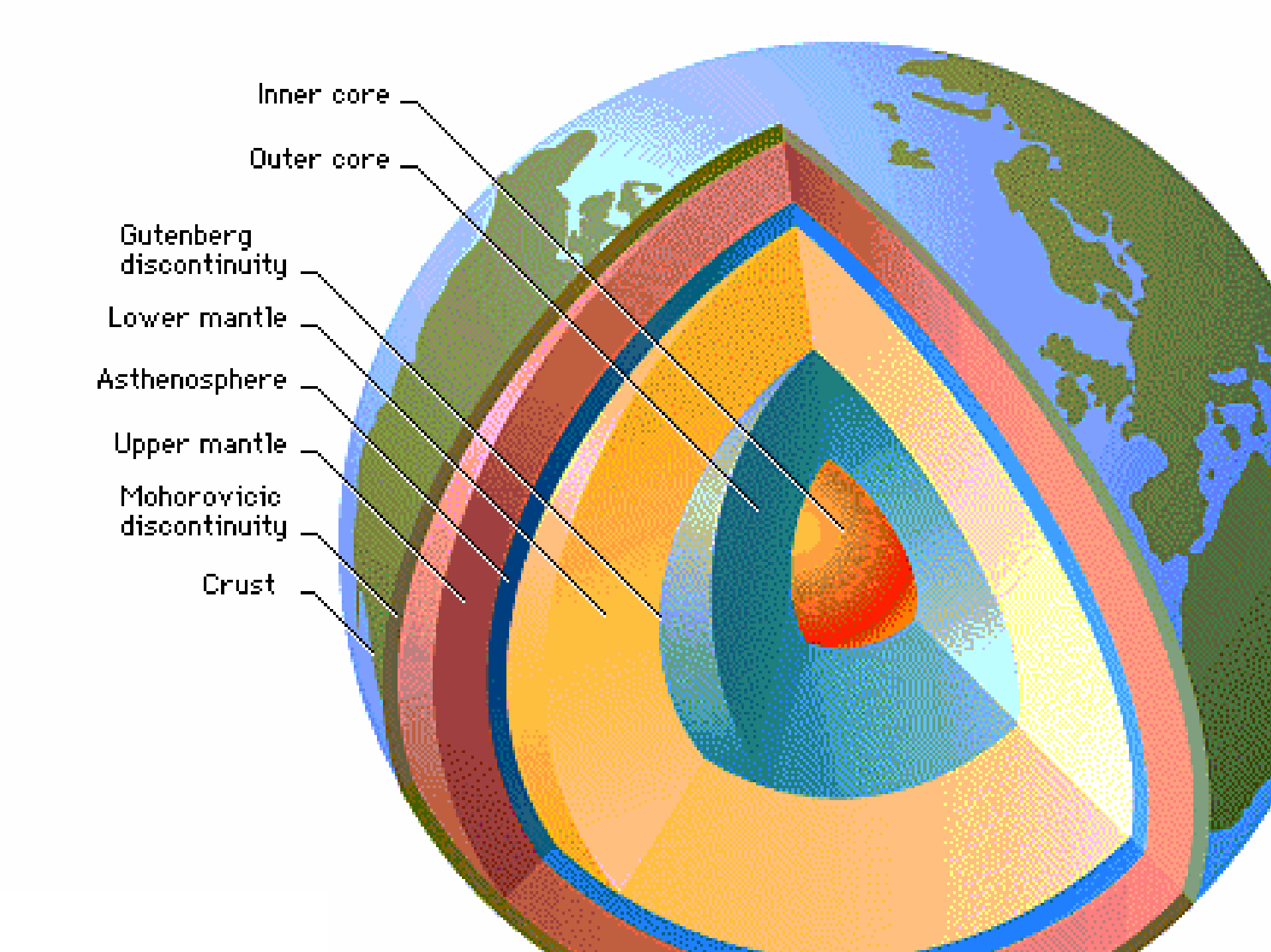


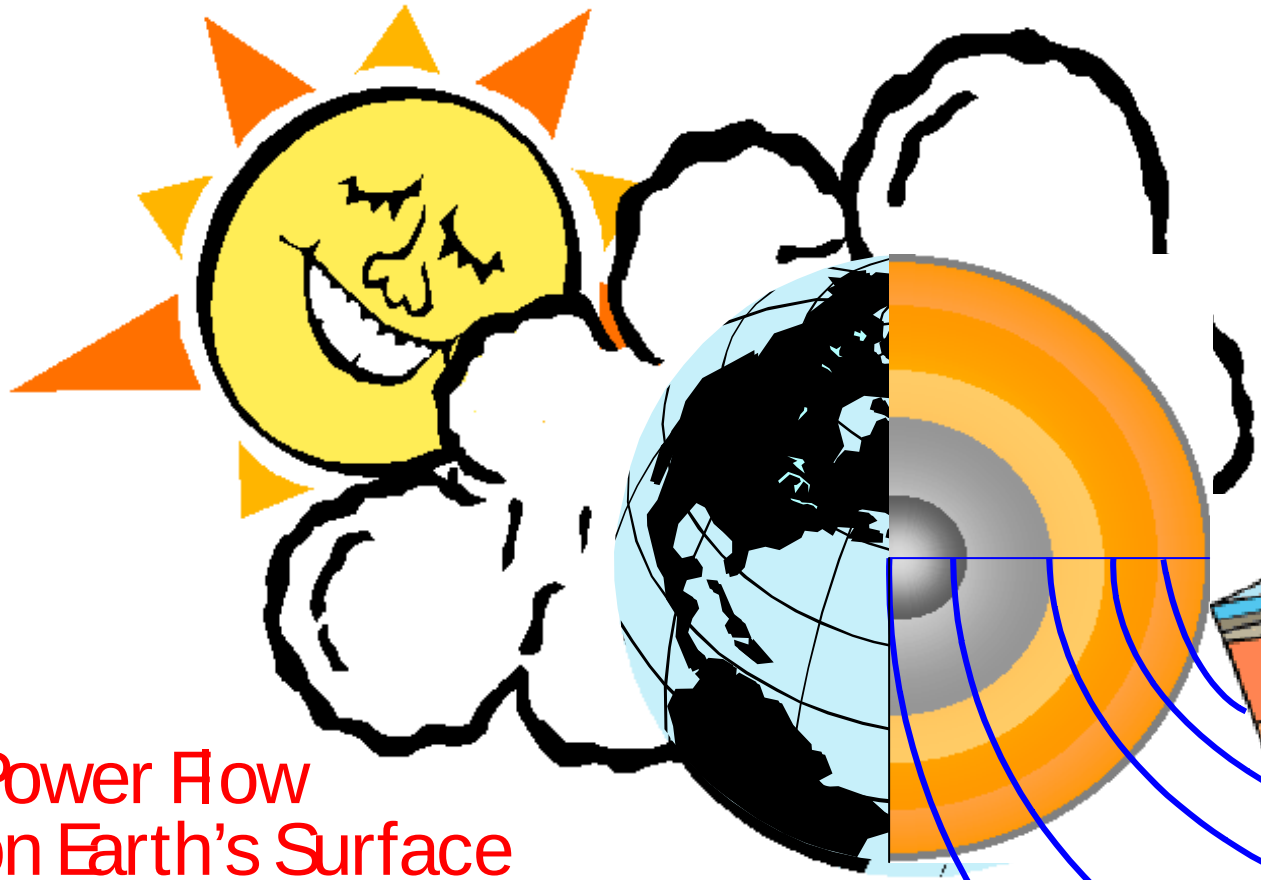


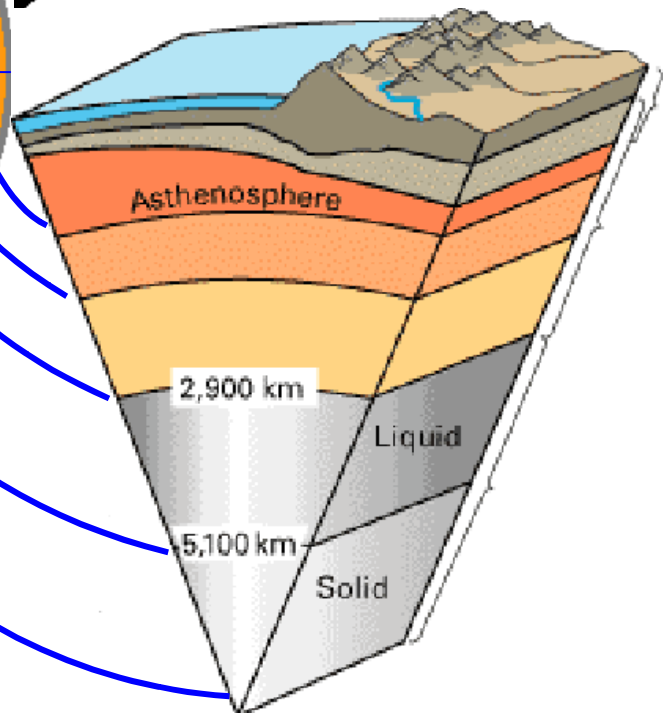
Isostatic balance

Mountains have "roots"




Inner core
Outer core
Gutenberg discontinuity
Lower mantle
Asthenosphere
Upper mantle
Mohorovicic discontinuity
Crust



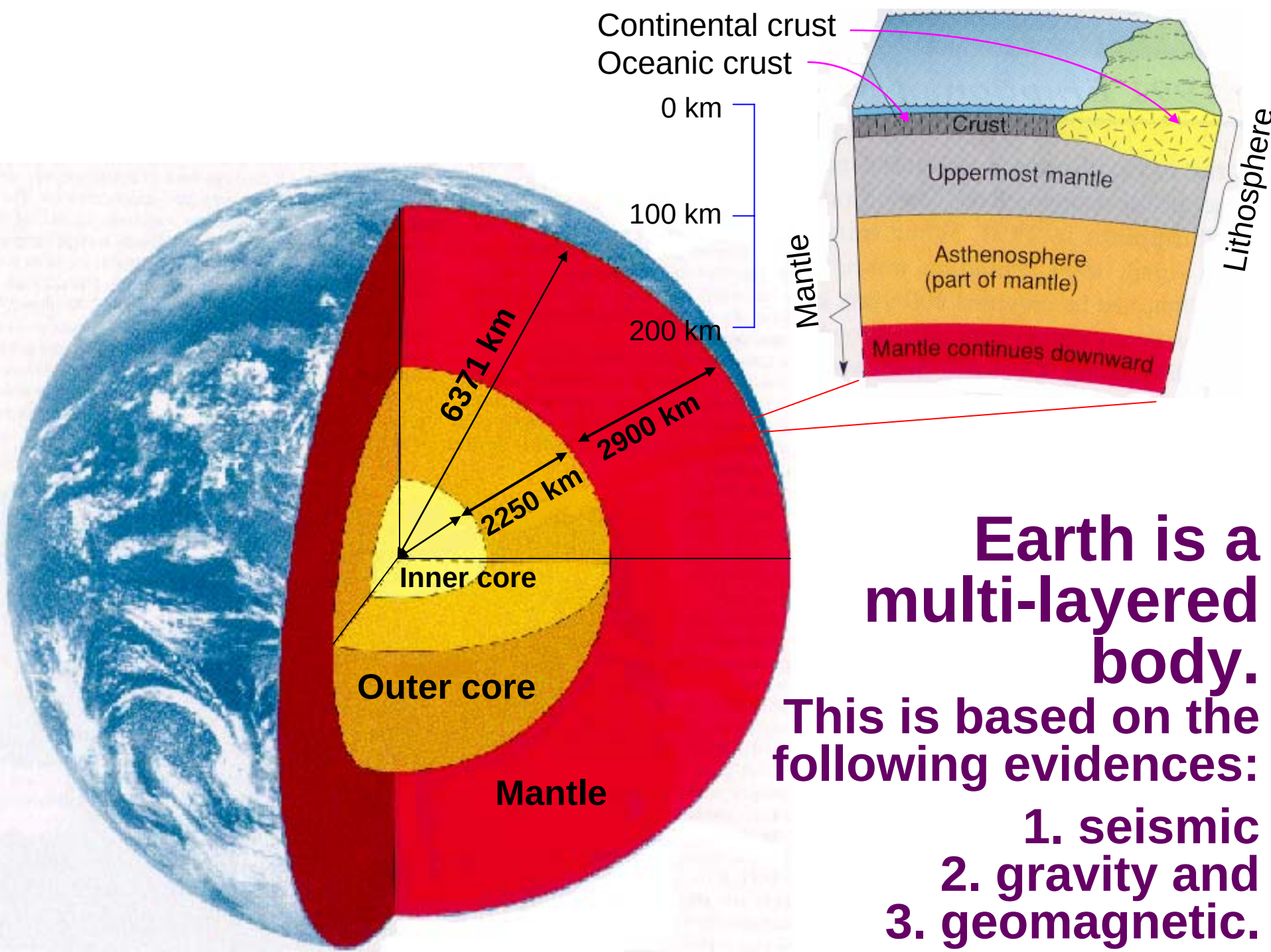


Power Flow on Earth's Surface

(trillion Joules per Second)

Solar radiation	173,410
direct reflection	52,000
direct conversion to heat	81,000
evaporation	40,000
water transport in oceans and atmosphere	370
photosynthesis	40

Internal heat	32.3
flow by conduction	32
volcanism/hot springs	0.3



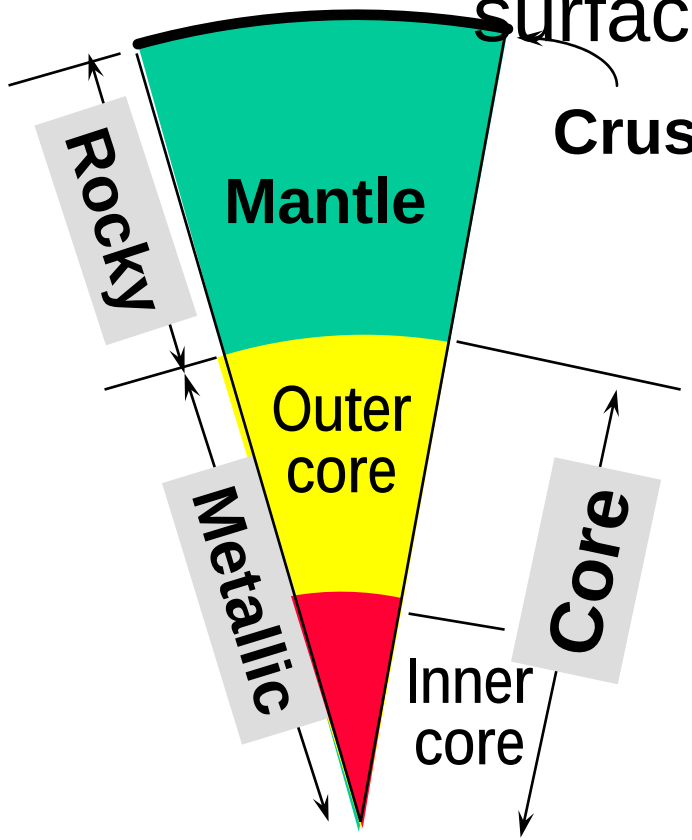
Earth is a multi-layered body.

This is based on the following evidences:

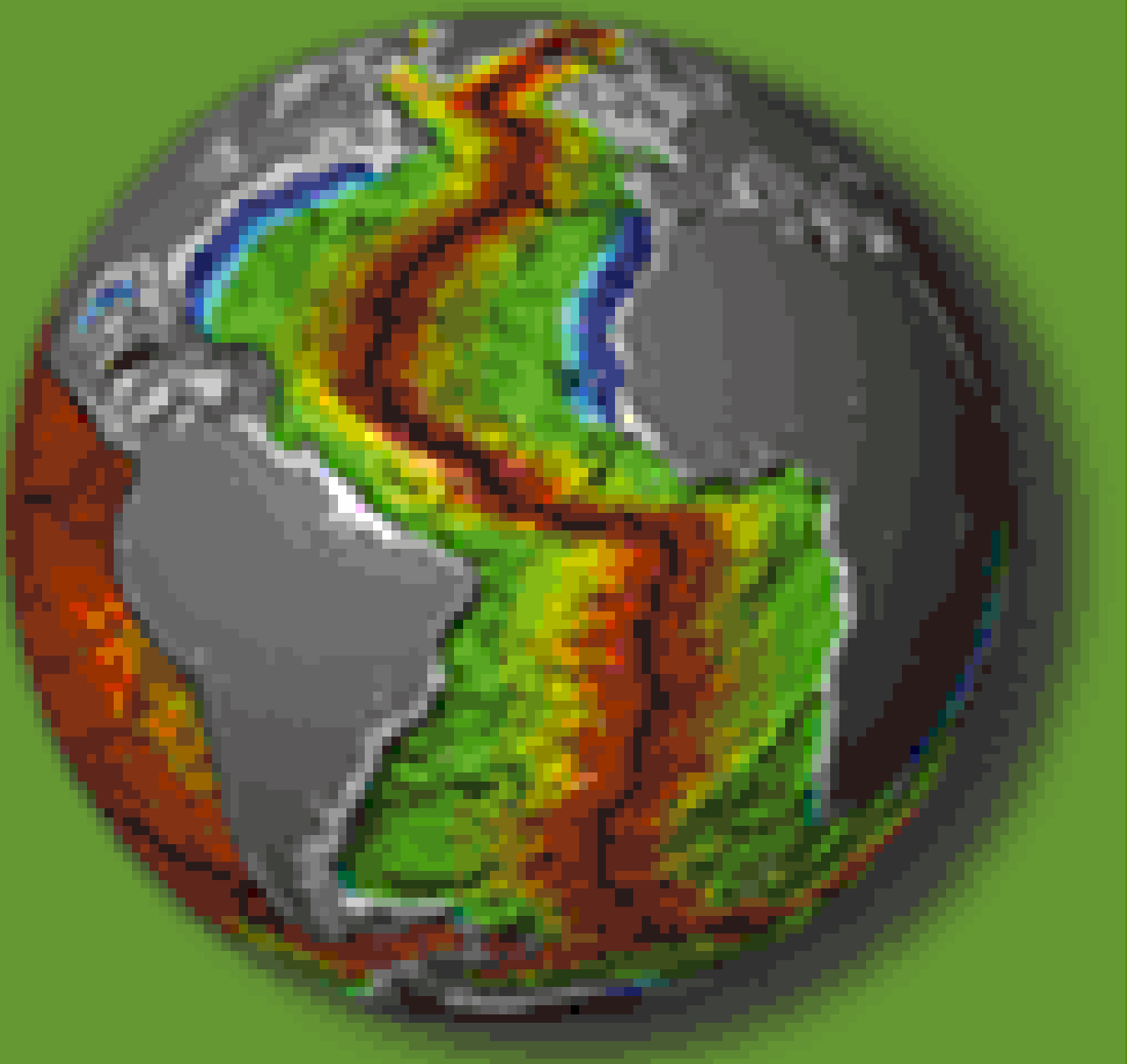
1. seismic
2. gravity and
3. geomagnetic.

		Universe	Whole Earth	Earth's Crust
Hydrogen	H	74.500		
Helium	He	23.840		
Oxygen	O	0.8200	29.8	46.6
Carbon	C	0.3750		
Nitrogen	N	0.0910		
Silicon	Si	0.0830	15.6	27.7
Neon	Ne	0.0550		
Magnesium	Mg	0.0570	13.9	2.1
Iron	Fe	0.1040	33.3	5.0
Sulphur	S	0.0380		
Aluminum	Al	0.0066	1.5	8.1
Calcium	Ca	0.0074	1.8	3.6
Nickel	Ni	0.0092	2.0	
Sodium	Na	0.0033	0.2	2.8
Argon	Ar	0.0030		
Chromium	Cr	0.0032		
Phosphorous	P	0.0009		
Manganese	Mn	0.0011		
Chlorine	Cl	0.0006		
Potassium	K	0.0003		2.6
Other elements			1.9	1.5

The whole earth is richer in Fe, Mg and Ni, and poorer in Si, K and Al, than what is found on the earth's surface.



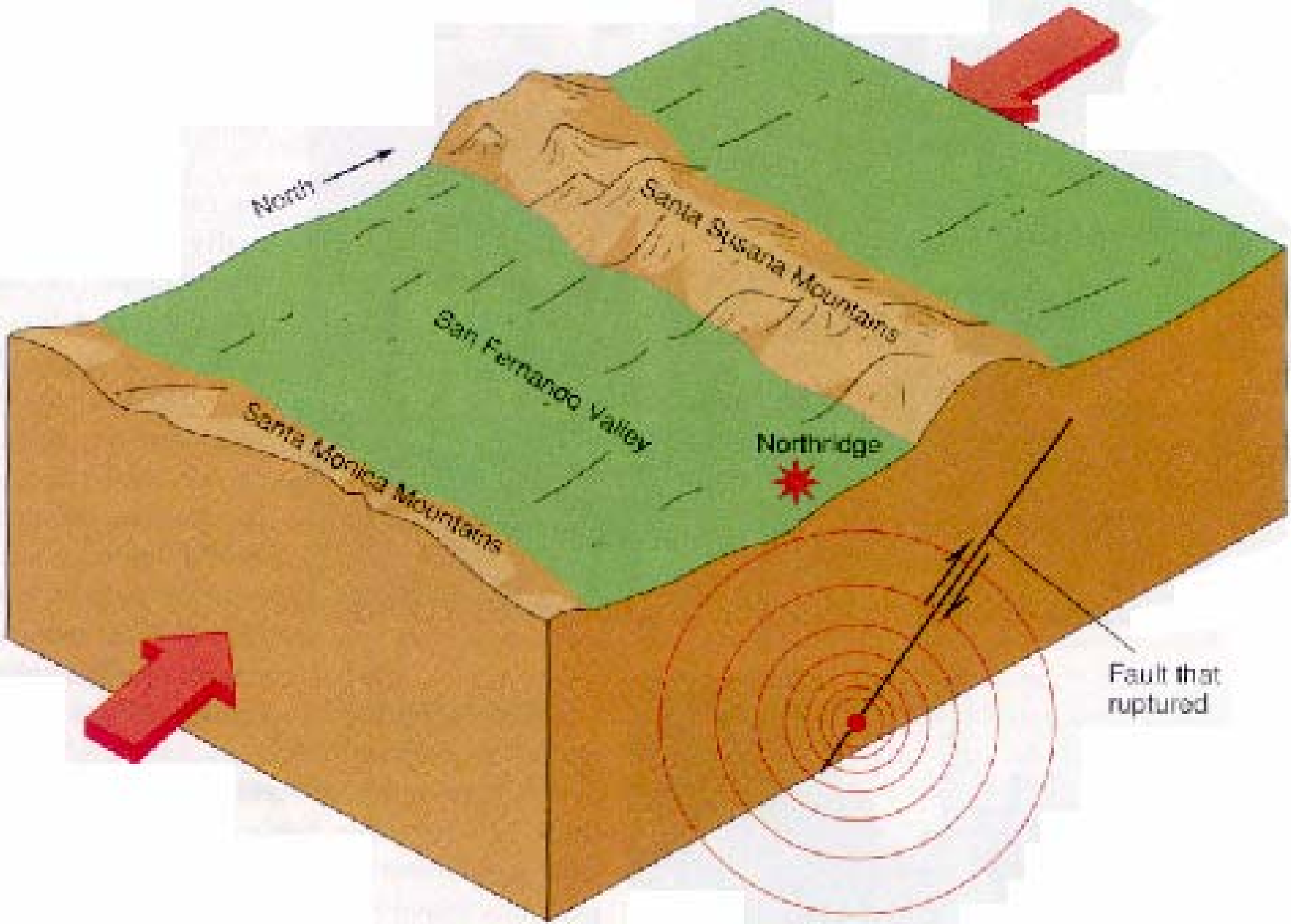
Whole Earth density = 5.5 gm/cm^3
Density of the crust = 2.7 gm/cm^3



Columbia Earthquake, February 1999

The damages from January 17, 1994, Northridge earthquake included

1. collapse of Northridge Meadows Apartments building that killed 16 people (one third of all the fatalities),
2. destruction of the parking garage at CSUN, and
3. damage to the overpasses of Interstate 5 near Castaic Junction


North
Santa Susana Mountains
San Fernando Valley
Santa Monica Mountains
Northridge
Fault that ruptured

Californians must shed 300 million pounds of flab

"Greater San Francisco is home to about 5 million. That means there's about 300 million pounds of excess stress on those weak spots.

"The 6.6 shaker, which devastated L.A. back in January, was the direct result of too much weight in too concentrated an area and so was the Earthquake that rocked San Francisco in 1906.

"Citizens in those California cities must go on the mother of all diets — now. My studies indicate that if each

EXPERT
Dr. Fritz Weller

lay 'the big one' indefinitely."

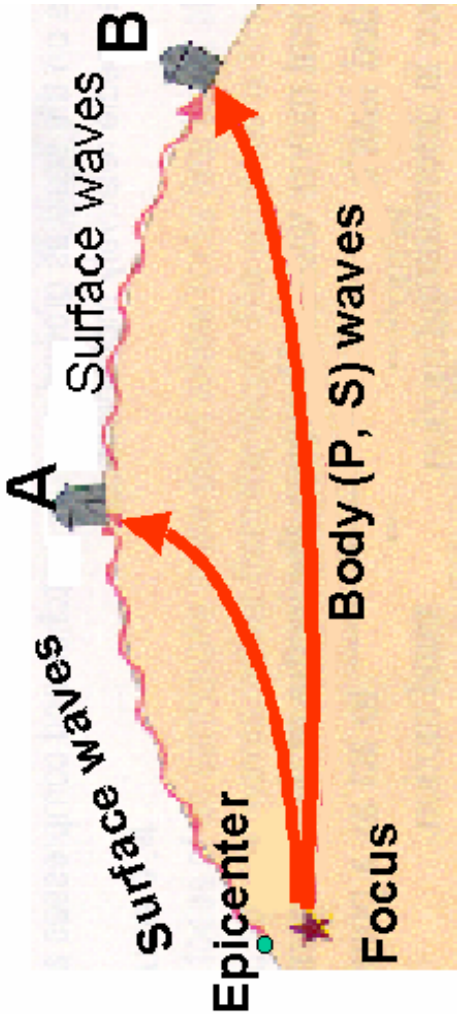
Critics say Dr. Weller's theories run contrary to everything science has known for years about what causes tremors.

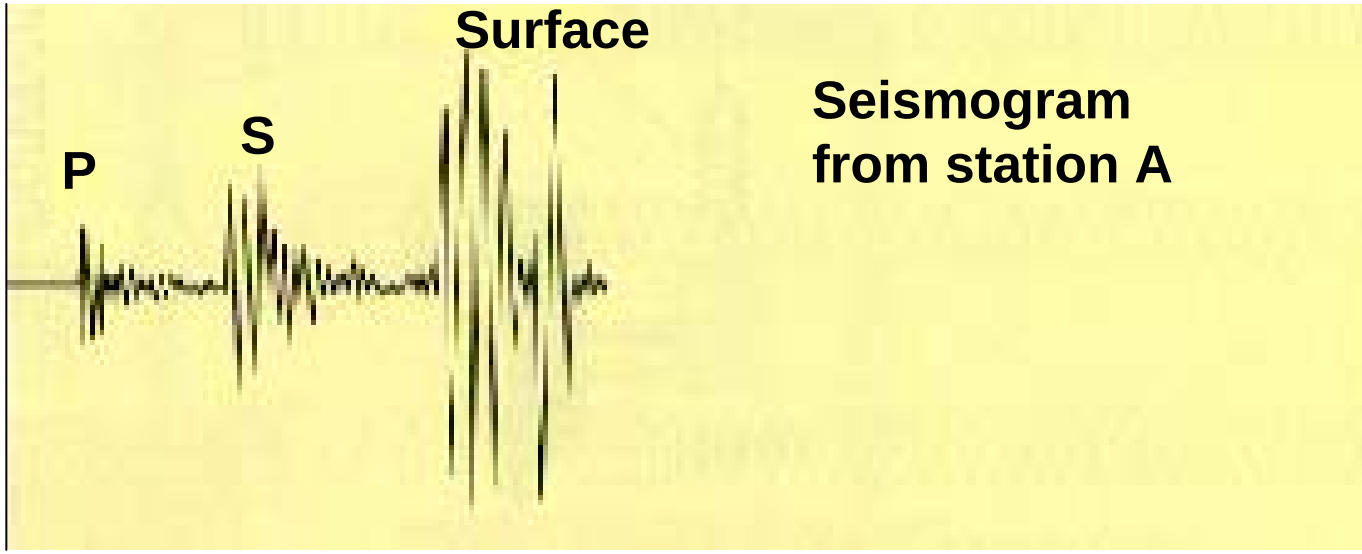
"Until I see a lot more research I'll have trouble accepting Dr. Weller's ideas," says French geologist Louis Bardot.

But Dr. Weller has made a painstaking study of seismographic records from all over the world for the last 20 years.

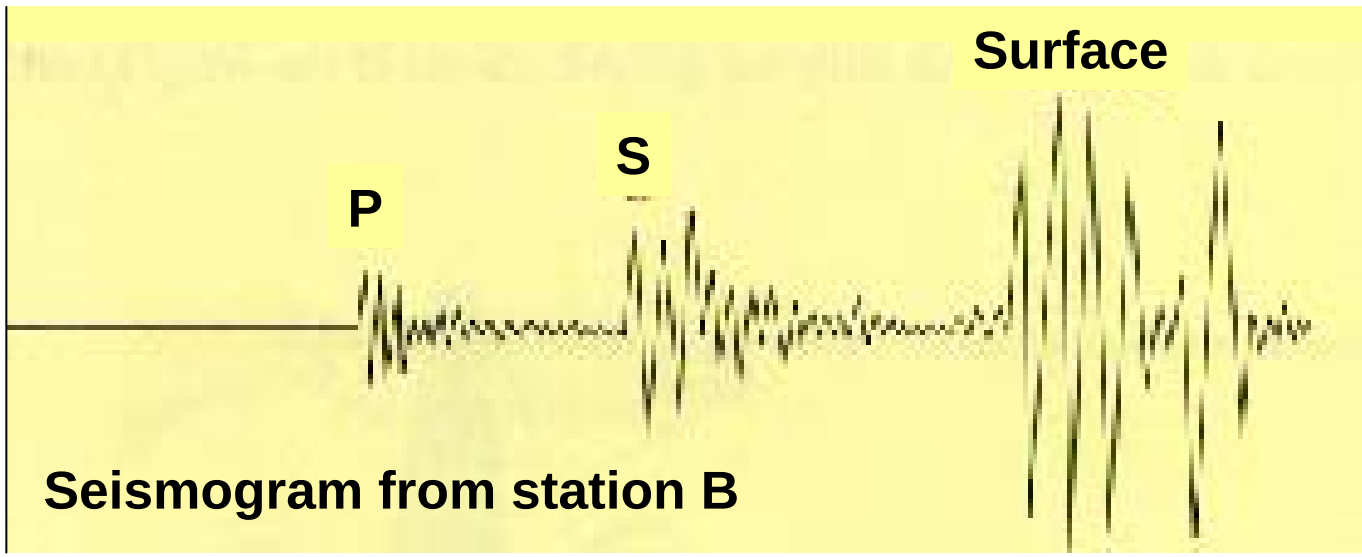
"There's a very clear corre-

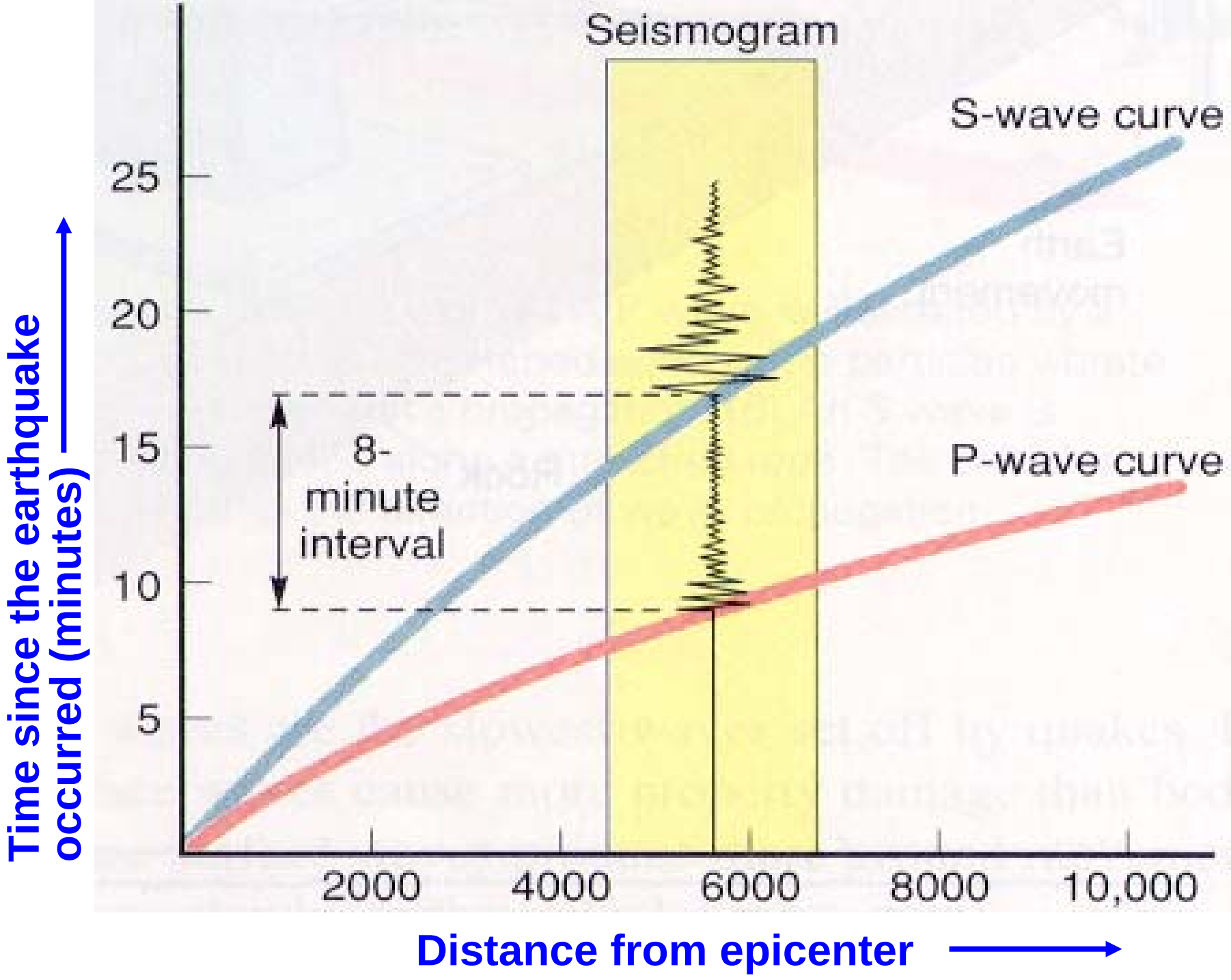
. . . because their excess weight causes EARTHQUAKES, warns expert!





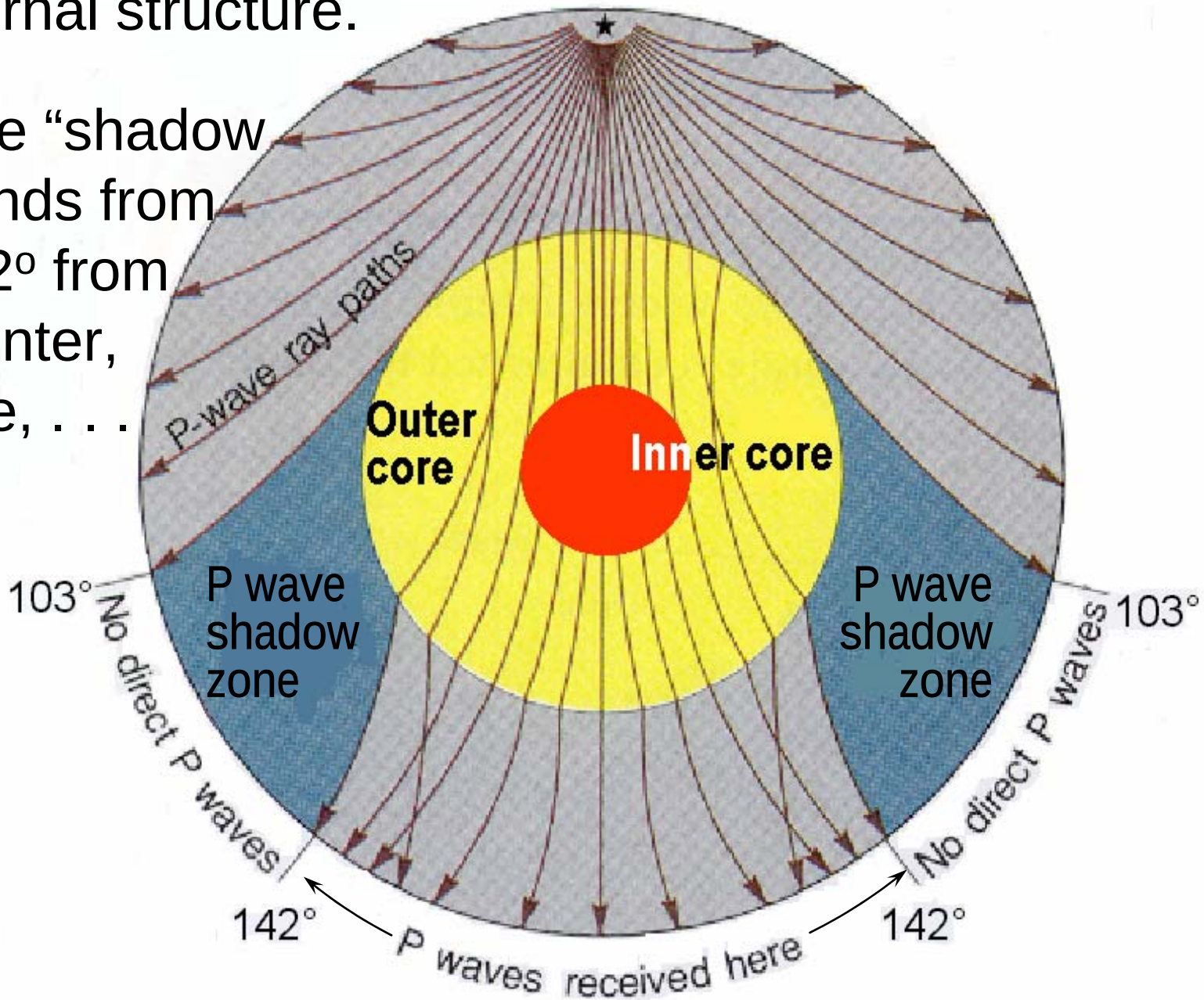
Time since the earthquake occurred




Seismogram
S-wave curve
P-wave curve
8-
minute
interval
25
20
15
10
5
2000
4000
6000
8000
10,000
Time since the earthquake occurred (minutes)
Distance from epicenter

P and S waves also yield information on the earth's internal structure.

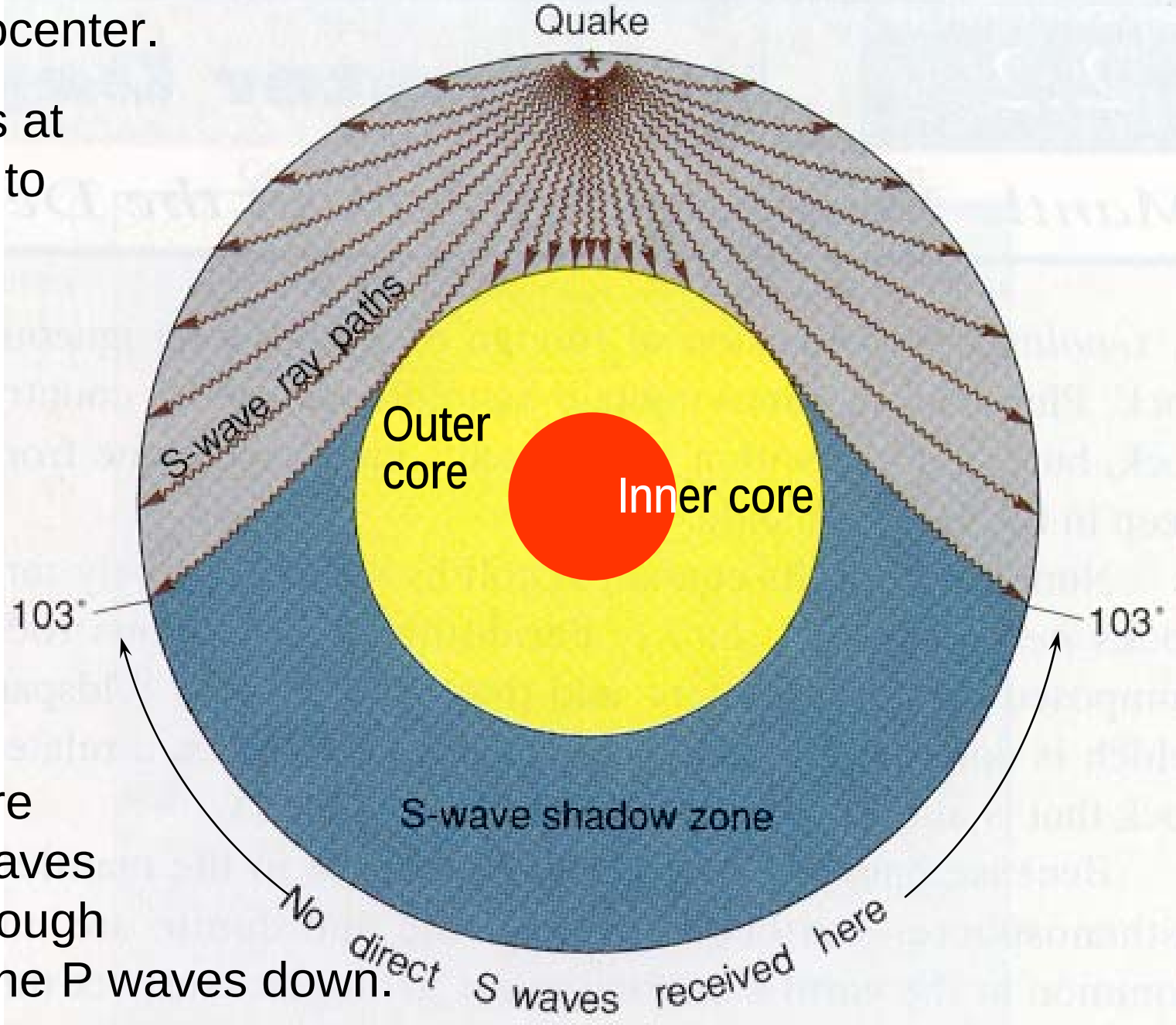
The P-wave "shadow zone" extends from 103° to 142° from the hypocenter, for instance, . . .



. . . whereas the S-wave “shadow zone” extends beyond 103º from the hypocenter.

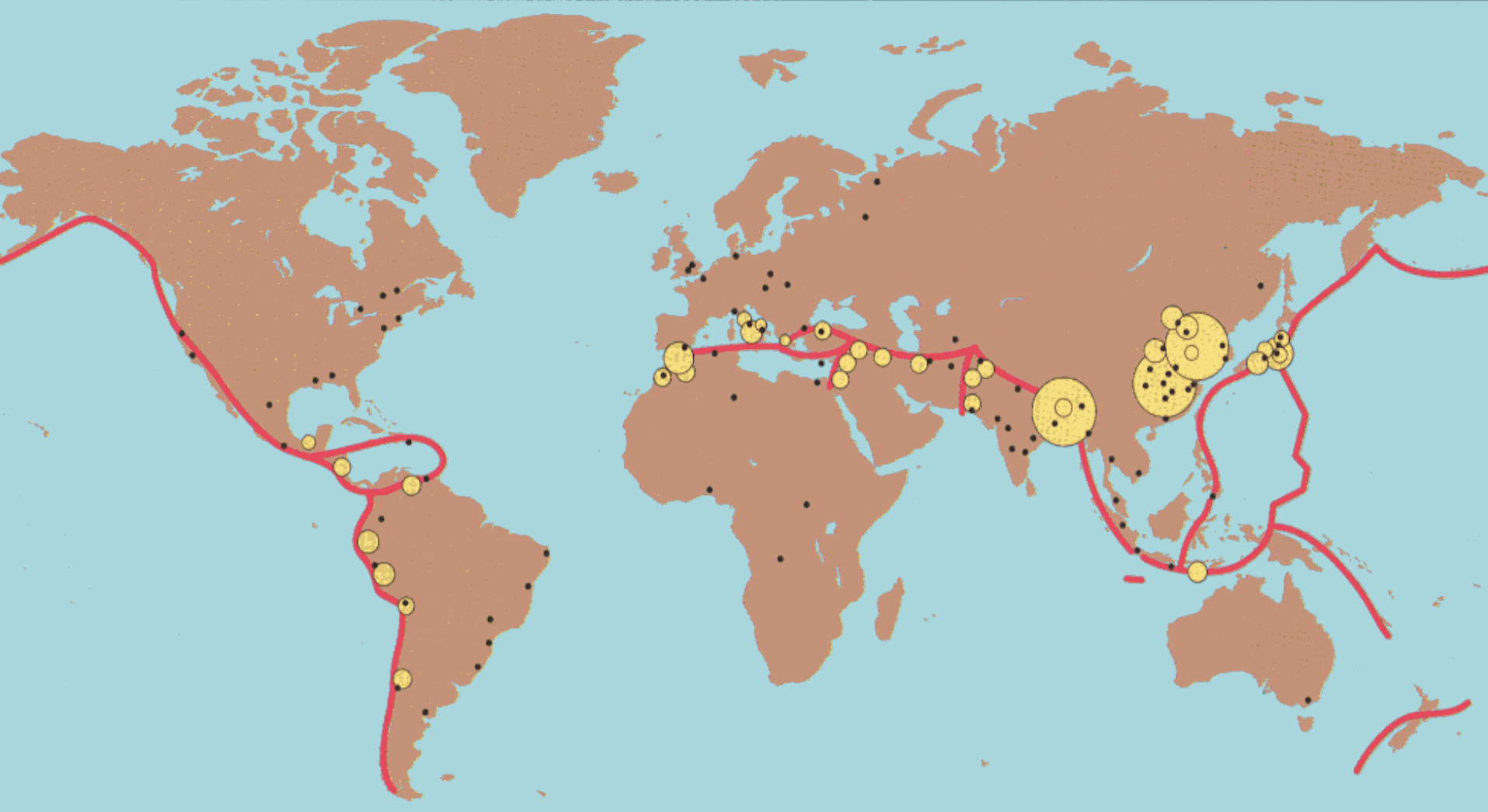
Seismograms at stations 103º to 142º from the hypocenter thus receive no direct P or S waves from that earthquake.

This occurs because the fluid outer core prevents S waves traversing through it and slows the P waves down.



Question

Upsala (59°52'N:17°38'E), Sweden, is located 130.57° from Northridge (34°14'N:118°38'W), CA. Could we, then, have expected more reliable estimates of magnitude and related parameters for January 17, 1994, Northridge earthquake from Upsala Seismological Observatory than from the U.S. Geological Survey at Denver, CO?

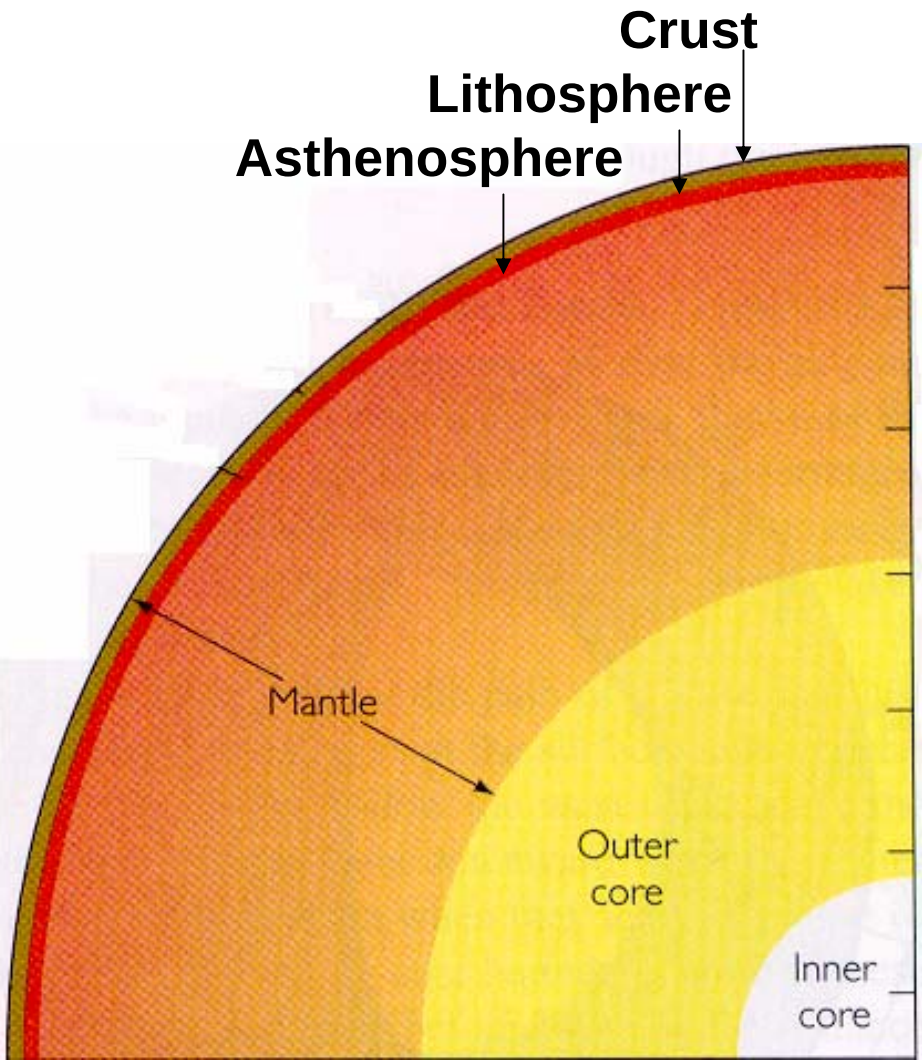


Earthquake fatalities from AD 1000 to 1988

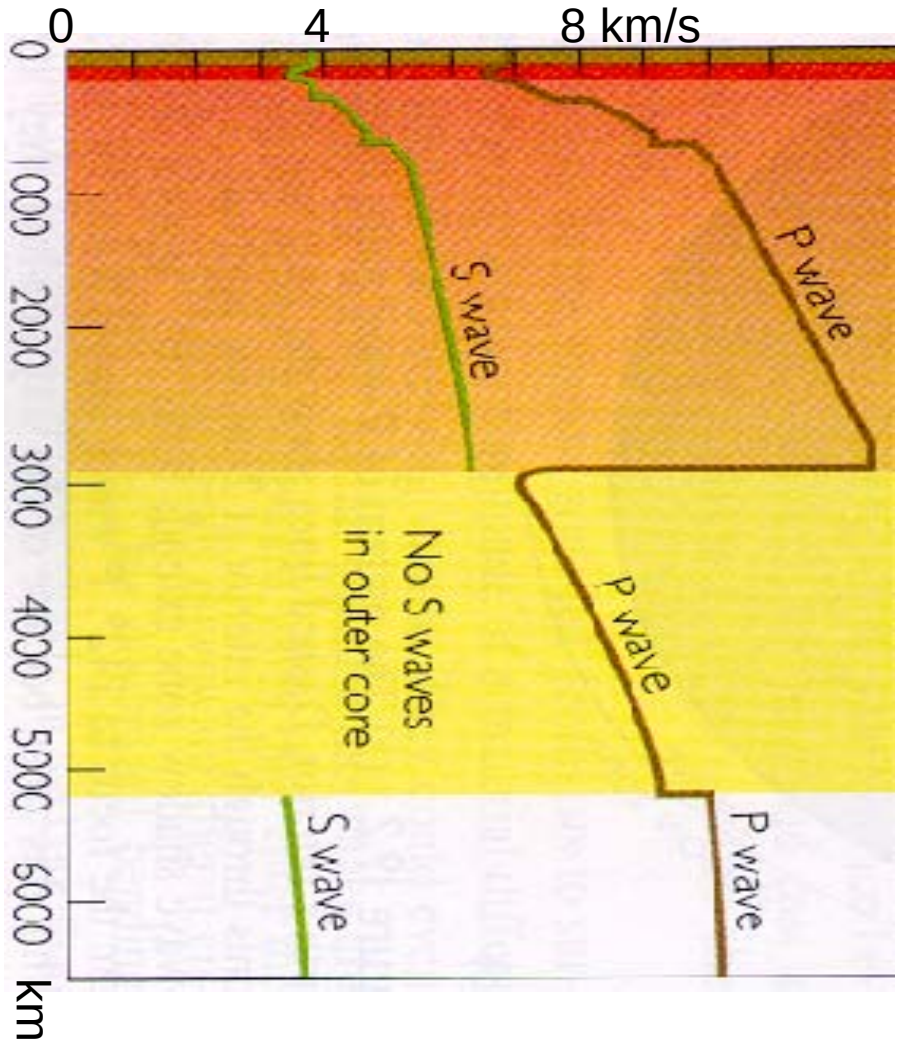
Fatalities exceeding:

- 300,000
- 90,000
- 10,000

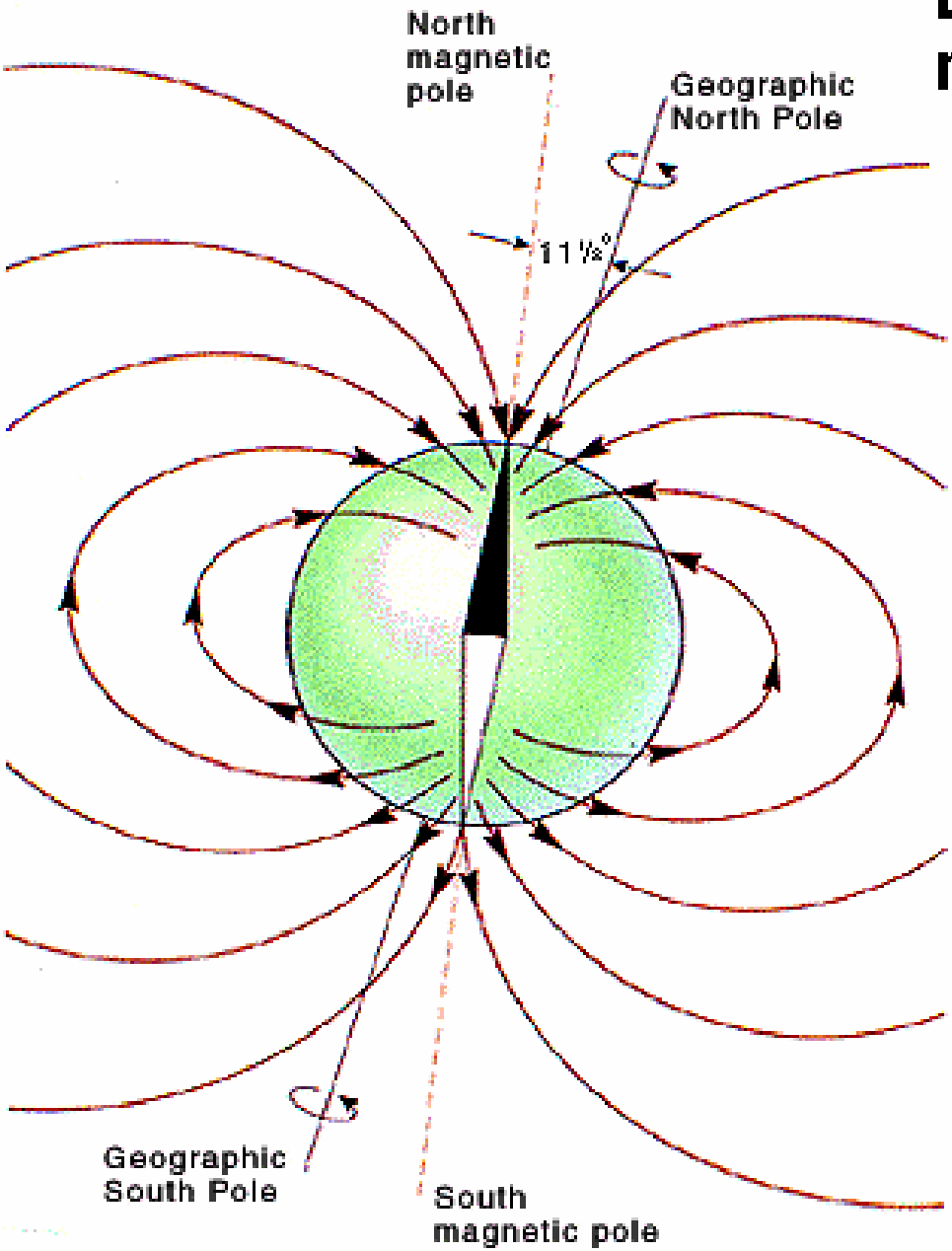
- Cities with population of 2 million by the year 2000
- Convergent or transform plate boundaries

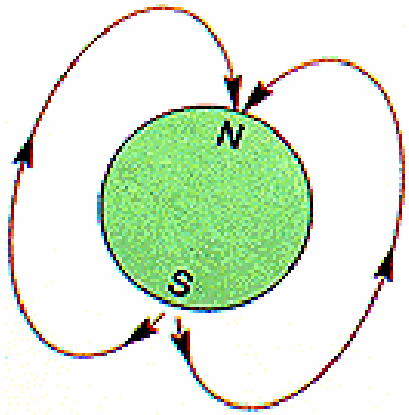


Seismic Wave Velocity

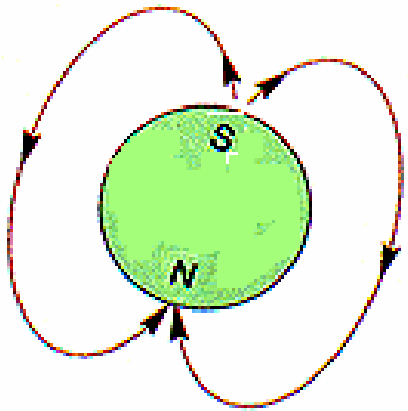


Earth has a magnetic field ...





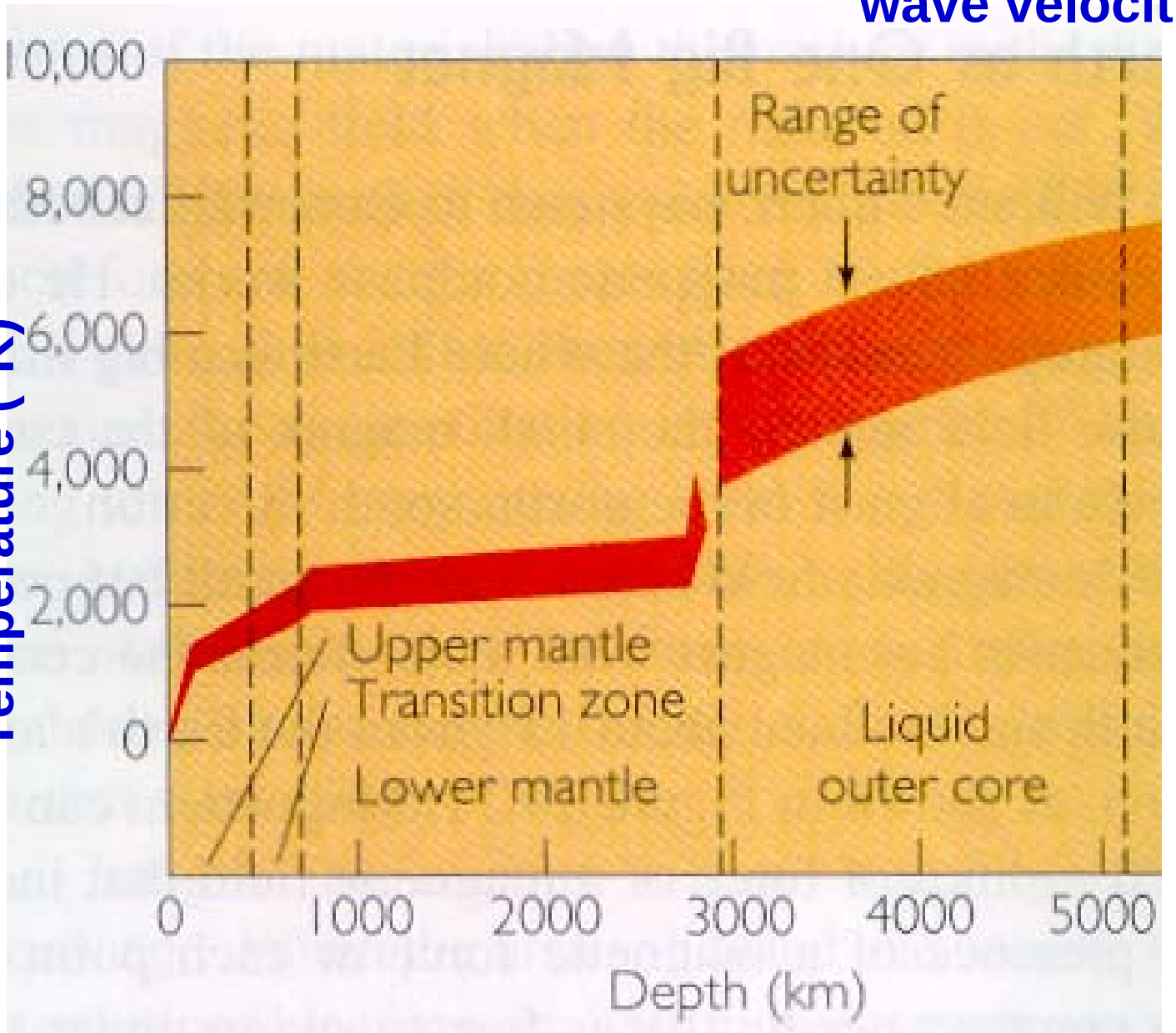
Normal polarity



Reversed polarity

... that has often flipped its polarity

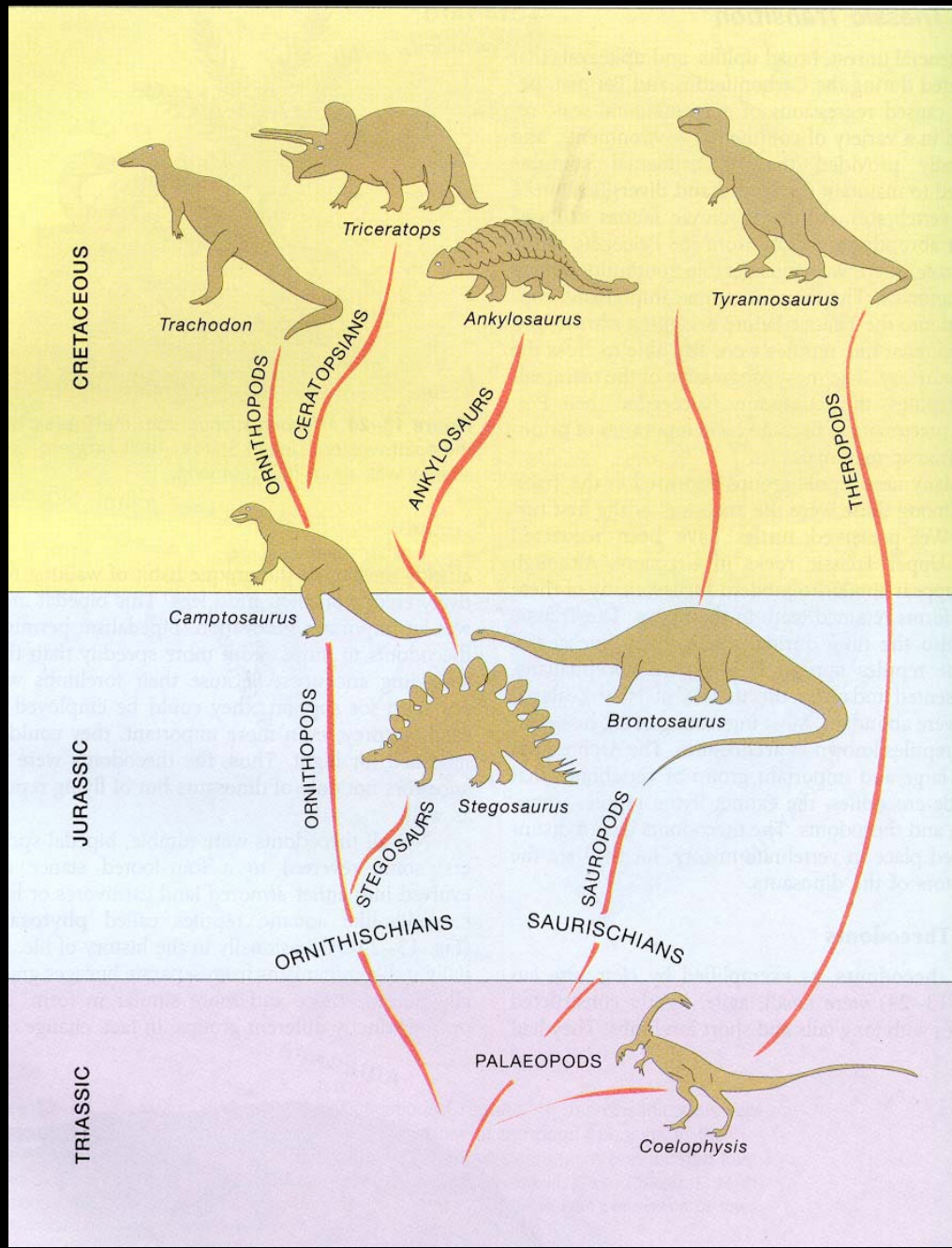
Estimated increase in temperature with depth in the Earth, as inferred from studies of volcanoes, seismic wave velocities, laboratory experiments and theory*.

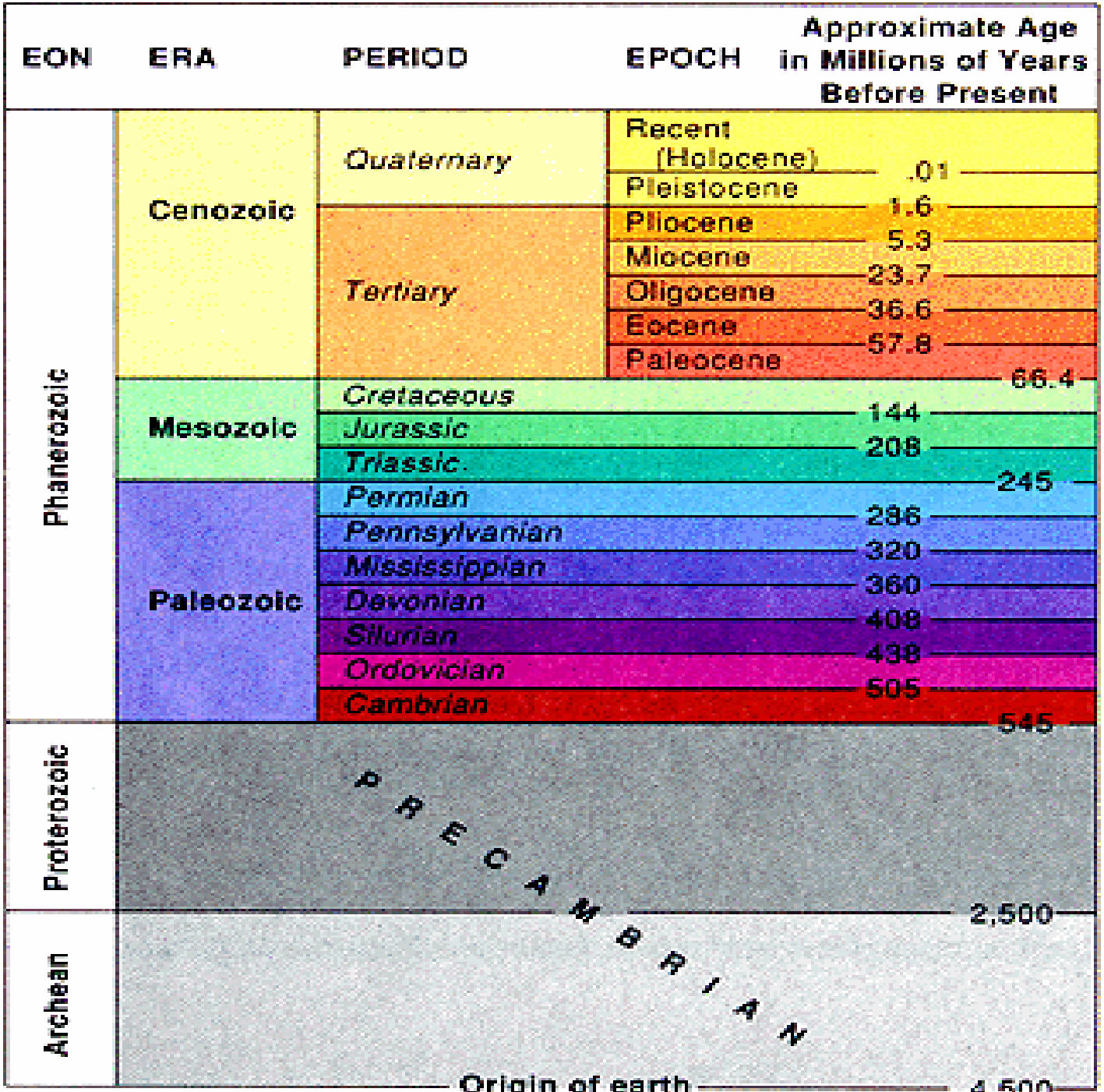


Source:
M.S.T. Bukowinski:
Nature, Sept 30, 1999
pp. 432-433

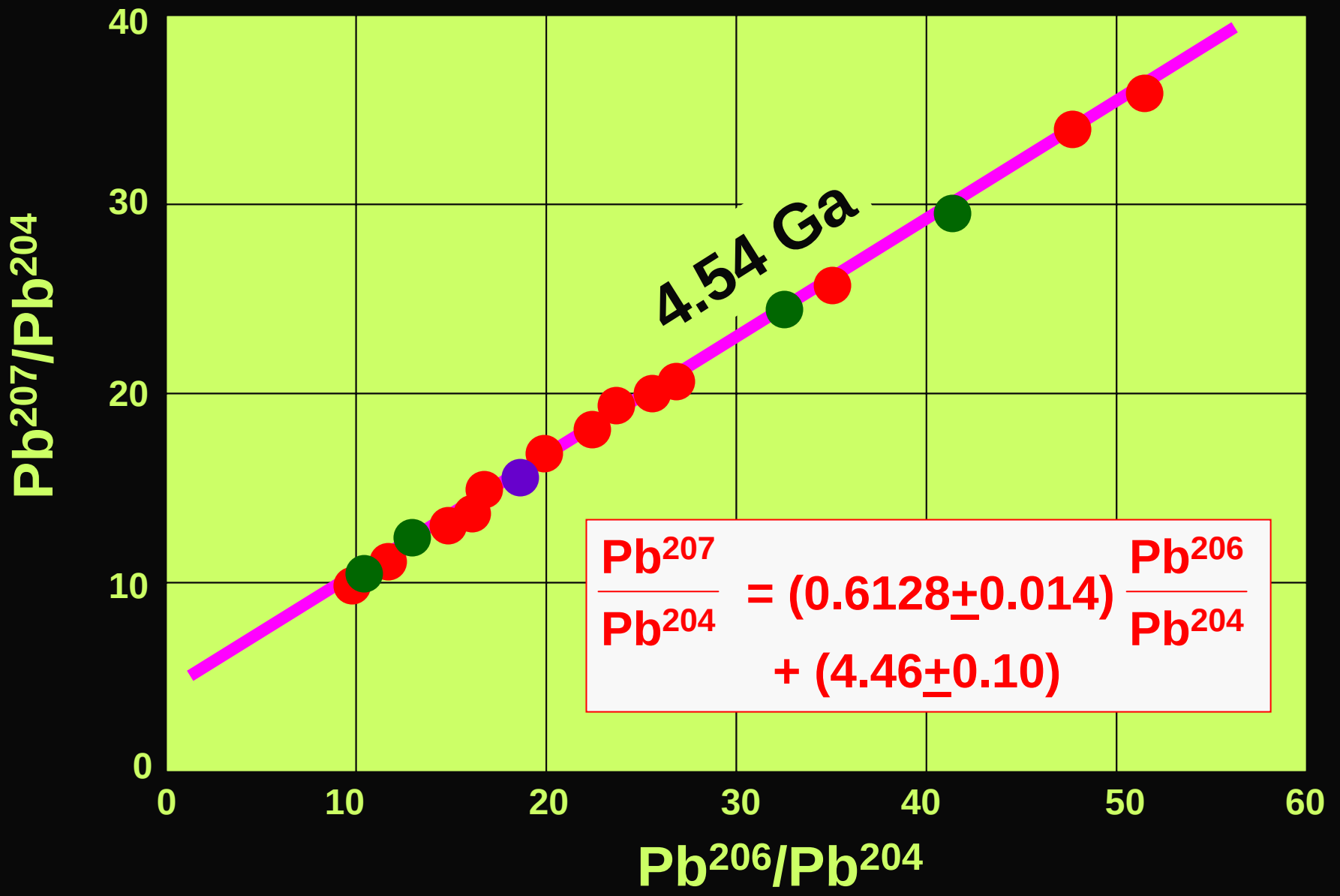
Dinosaurs had dominated the Mesozoic life but vanished at the Cretaceous-Tertiary boundary without leaving any trace

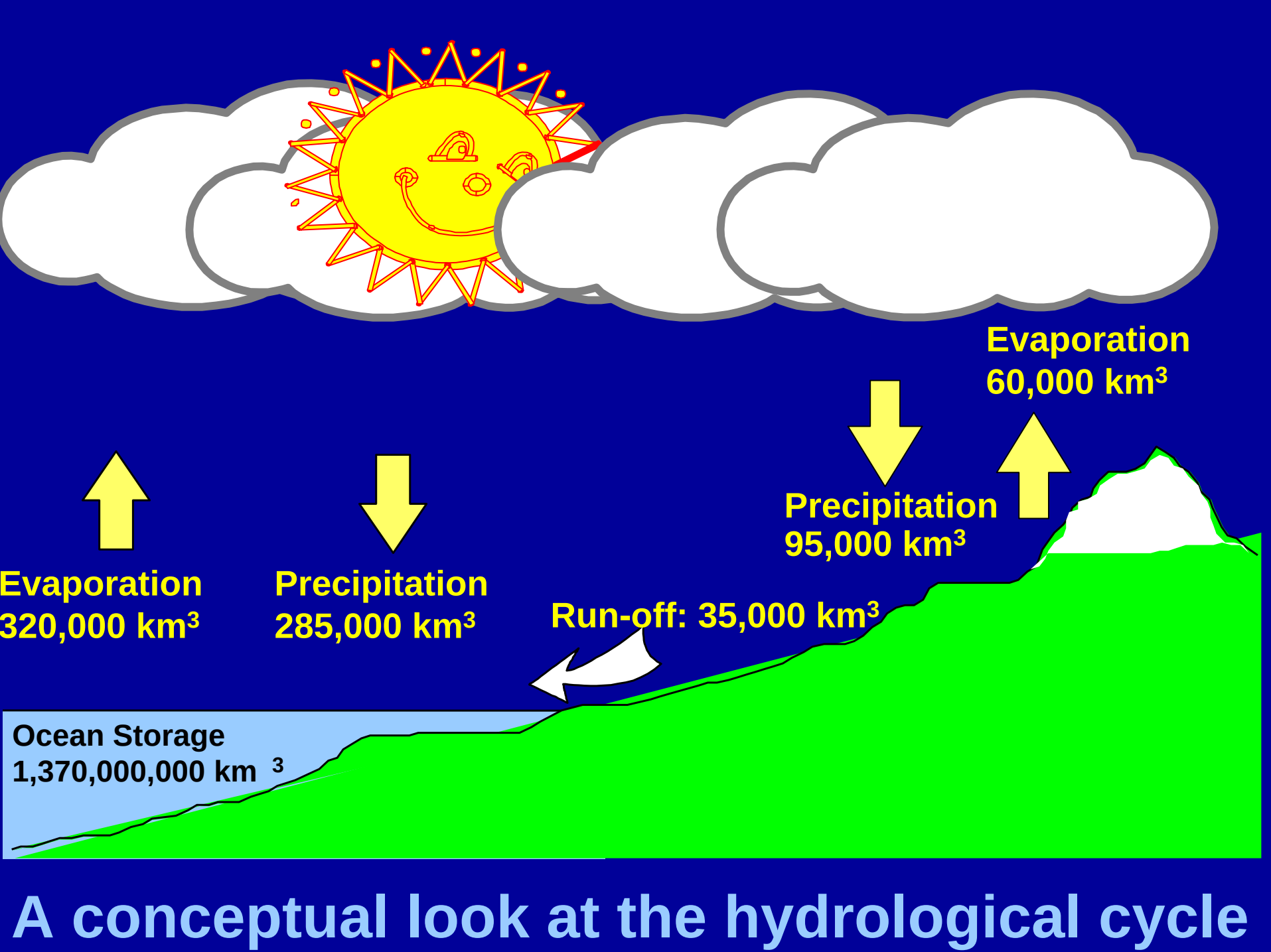
Phanerozoic	Cenozoic	Quaternary	Holocene	0
			Pleistocene	2
		Tertiary	Pliocene	5
			Miocene	24
			Oligocene	37
			Eocene	58
			Paleocene	65
	Meso-zoic	Cretaceous		144
		Jurassic		208
		Triassic		245
	Paleozoic	Permian		286
		Carboniferous		360
		Devonian		408
		Silurian		438
		Ordovician		505
		Cambrian		570
Proterozoic				2500
Azoic or Archean				3800
Earth's evolution				4700




EON
ERA
PERIOD
EPOCH
Approximate Age in Millions of Years Before Present
Phanerozoic
Cenozoic
Quaternary
Recent (Holocene)
.01
Pleistocene
1.6
Tertiary
Pliocene
5.3
Miocene
23.7
Oligocene
36.6
Eocene
57.8
Paleocene
66.4
Mesozoic
Cretaceous
144
Jurassic
208
Triassic
245
Paleozoic
Permian
286
Pennsylvanian
320
Mississippian
360
Devonian
408
Silurian
438
Ordovician
505
Cambrian
545
Proterozoic
PRECAMBRIAN
2,500
Archean
Origin of earth
4,500

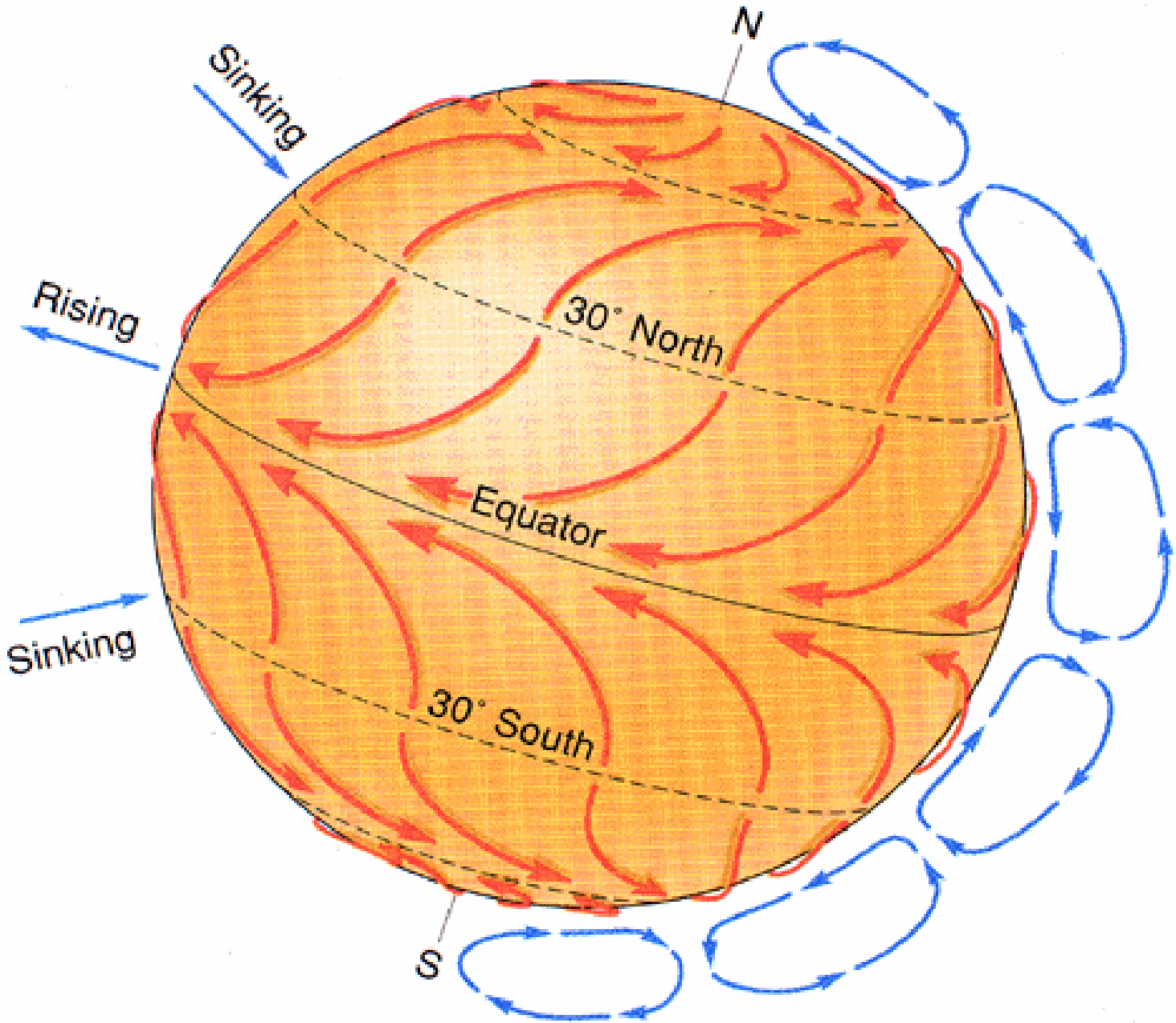
The lead-lead isochron for meteorites





A conceptual look at the hydrological cycle

Global air circulation



World distribution of nonpolar deserts