Geosciences 225

Professors:

- Tony Dahlen — Lecturer
- Laurel Goodell — Laboratory Manager
- Karin Sigloch — Laboratory Instructor
- Mark Davidson — Homework Grader

Textbook:

- *Understanding Earth*, Fourth Edition, 2003
  Press, Siever, Grotzinger & Jordan
- Useful for vocabulary
- Excellent photos and illustrations
- Not very quantitative
- To be thought of as a third segment of the course (in addition to lectures and labs)

Syllabus:

- first quarter — elements, rocks and time
- second quarter — water and mud
- third quarter — heat and earthquakes
- fourth quarter — the earth as man's abode

Geosciences 225

Homework — 10% of grade

- one problem set every quarter

Exams — 40% of grade

- four closed-book in-class exams — 10% each
- no comprehensive final exam

Laboratories — 25% of grade

- one three-hour lab every week
- one daylong field trip Sunday, October 17

Term Paper: — 25% of grade

- scientific or technical research paper
- no assigned topic — it's your choice
- due on Dean's Date, January 11

Size (km)	Orders of Magnitude Larger Than Earth	Significant Distances
10^{23}	19	Diameter of Universe
10^{22}	18	
10^{21}	17	
10^{20}	16	
10^{19}	15	Distance to Nearest Galaxy Like Ours
10^{18}	14	
10^{17}	13	Diameter of Our Galaxy
10^{16}	12	
10^{15}	11	
10^{14}	10	
10^{13}	9	Distance to Nearest Star (Alpha Centauri, Sun)
10^{12}	8	
10^{11}	7	
10^{10}	6	Diameter of Solar System (Pluto, Sun)
10^{9}	5	
10^{8}	4	Astronomical Unit (Earth, Sun)
10^{7}	3	
10^{6}	2	Diameter of Sun
10^{5}	1	Diameter of Jupiter
10^{4}	0	Diameter of Earth
10^{-3}	7	Child 1 m
10^{-8}	12	Cell
10^{-13}	17	Atom 10^{-10} m
10^{-16}	20	Nucleus
10^{-20}	24	Electron

Figure 2.1. Sizes of various objects over the enormous range that the natural world encompasses. From Robbins and Jeffreys (1988) by permission of John Wiley and Sons.

First Class — Friday — Organization

GEO 225 has three ingredients:

- book by ~~J & R~~ Press & Sievert — presents an overview of topic — good for vocabulary & qualitative descriptions

- lectures — pick a few topics, cover in more detail than book — pick topics that lend themselves to simple quantitative analysis

- labs — also quasi-independent, though timing is ~ tied to class

Basis of grading

~~Exams~~ Learn-by-Teaching Project in lieu of term paper

One day field trip to Delaware Water Gap and Northern New Jersey

Level of math required — only pre-calculus, no calculus

Fig. 2.1 Lunine shows tremendous range of scales studied in geology & astronomy.

Note — we <u>will</u> use power-of-ten (aka "scientific") notation

Question — how many atoms in a person?

Size of atom $\sim 10^{-10}$ m = 1 Å angstrom

Size of person ~ 1 m

Answer not simply 10^{10} because volumes are involved

Volume of an atom

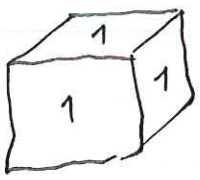
$$V_{atom} \approx \frac{4}{3}\pi (10^{-10}\ m)^3$$

$$\approx 4 \cdot 10^{-30}\ m^3$$

before the age of sex, drugs, rock & roll

Telephone booth packing — undisputed champ of 1950's

Volume of a person — ask how many fit in a $1\ m^3$ box?



Answer — between 10 and 20

[10 100 kg or 20 50 kg people]

$V_{person} \sim$ [redacted] $\frac{1}{20}\ m^3$ ← small people (50 kg each)

$$\#\ atoms = \frac{1/20\ [redacted]\ m^3}{4 \cdot 10^{-30}\ m^3}$$

$$\#\ atoms \cong [redacted]\ 10^{28}$$

More accurate answer — since not all atoms same size & difficult to estimate people's volumes —

Use mass instead

Ask — what are elements in a person?
Show periodic table

Answer : CH_2O C : H : O = 1 : 2 : 1

C : 12 gm/mole
H : 1 gm/mole
O : 16 gm/mole

$12 + (2 \times 1) + 16 = 30$

↓ a cox not a stoke

moles CH_2O in a 60 kg person

$$= \frac{60\ kg \times 10^3\ gm/kg}{30\ [redacted]\ gm/mole} = [redacted]\ 2000\ moles\ CH_2O$$

1 mole = Avogadro's number of "molecules"

$N = 6 \cdot 10^{23}$ molecules/mole

$\# \; CH_2O = (6 \cdot 10^{23})(2000)$

$= 10^{27}$

Thus a 60 kg person consists of

- 10^{27} C atoms
- $2 \cdot 10^{27}$ H atoms
- 10^{27} O atoms

$4 \cdot 10^{27}$ atoms

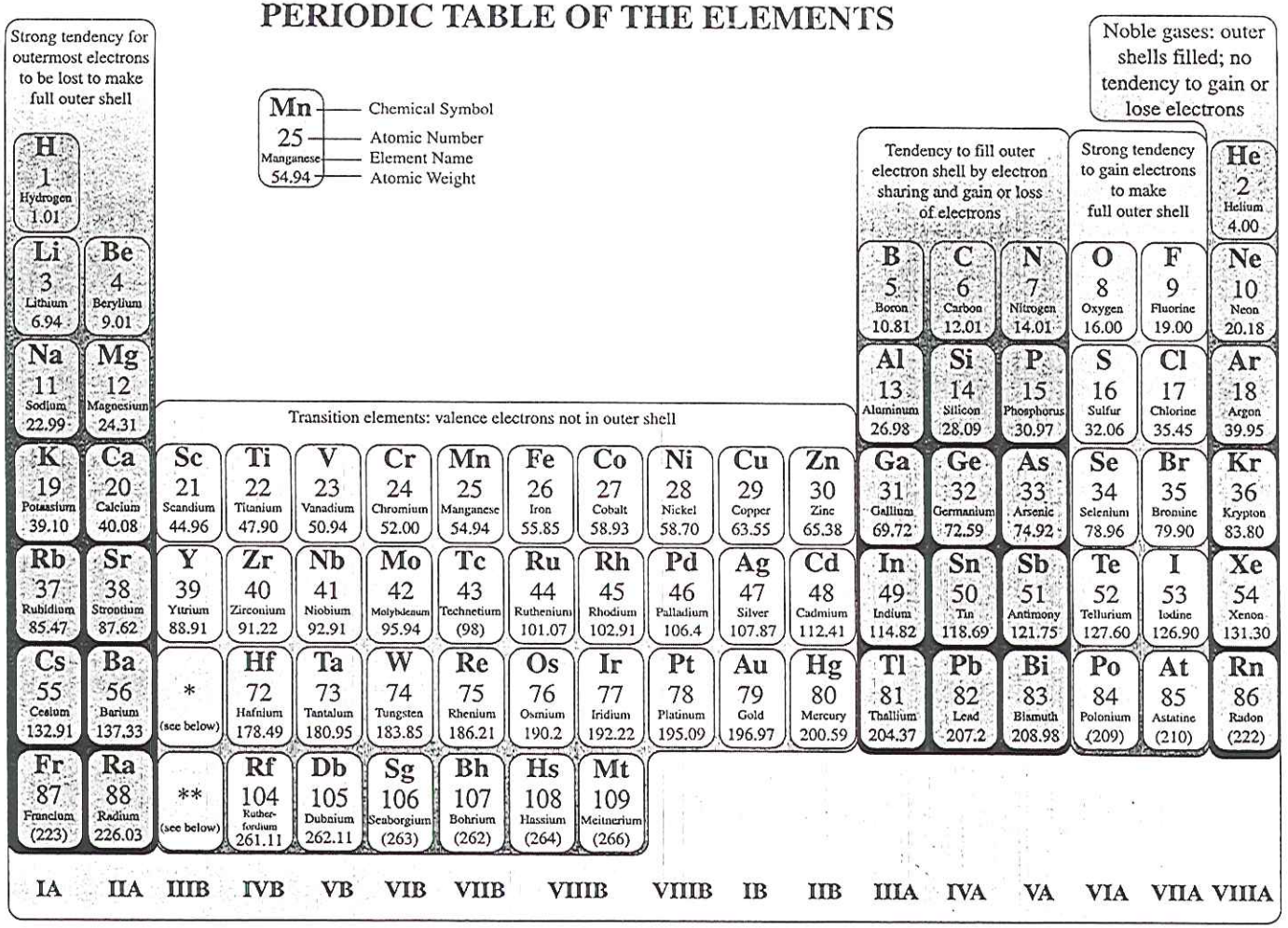
Question — which we shall address next time

What are the principal elements in the Earth? What are their relative proportions?

Just as for a person we need to begin with $V_\oplus$ and $M_\oplus$ — next time.


TELEPHONE

PERIODIC TABLE OF THE ELEMENTS



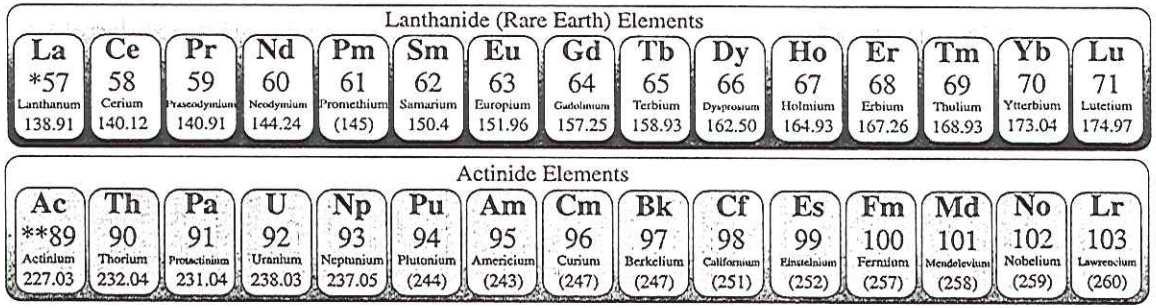


Table 5.1. Average Chemical Composition of Organic Matter

	Percentage Composition by Weight		
Element	*Carbohydrates*	*Fats*	*Proteins*
O	49.38	17.90	22.4
C	44.44	69.05	51.3
H	6.18	10.00	6.9
P		2.13	0.7
N		0.61	17.8
S		0.31	0.8
Fe			0.1
Total	100.00	100.00	100.00

Source: Rankama and Sahama 1950.