Welcome to 3.091

Donald R. Sadoway

John F. Elliott Professor of Materials Chemistry
Dept. of Materials Science & Engineering (Course III)

born Toronto, Ontario, CANADA

attended University of Toronto

1972 B.A.Sc. (Engineering Science)
1973 M.A.Sc. (Chemical Metallurgy)
1977 Ph.D. (Chemical Metallurgy)

1977 NATO Postdoctoral Fellow, MIT
1978 joined MIT faculty

basic research:

electrochemistry in nonaqueous media

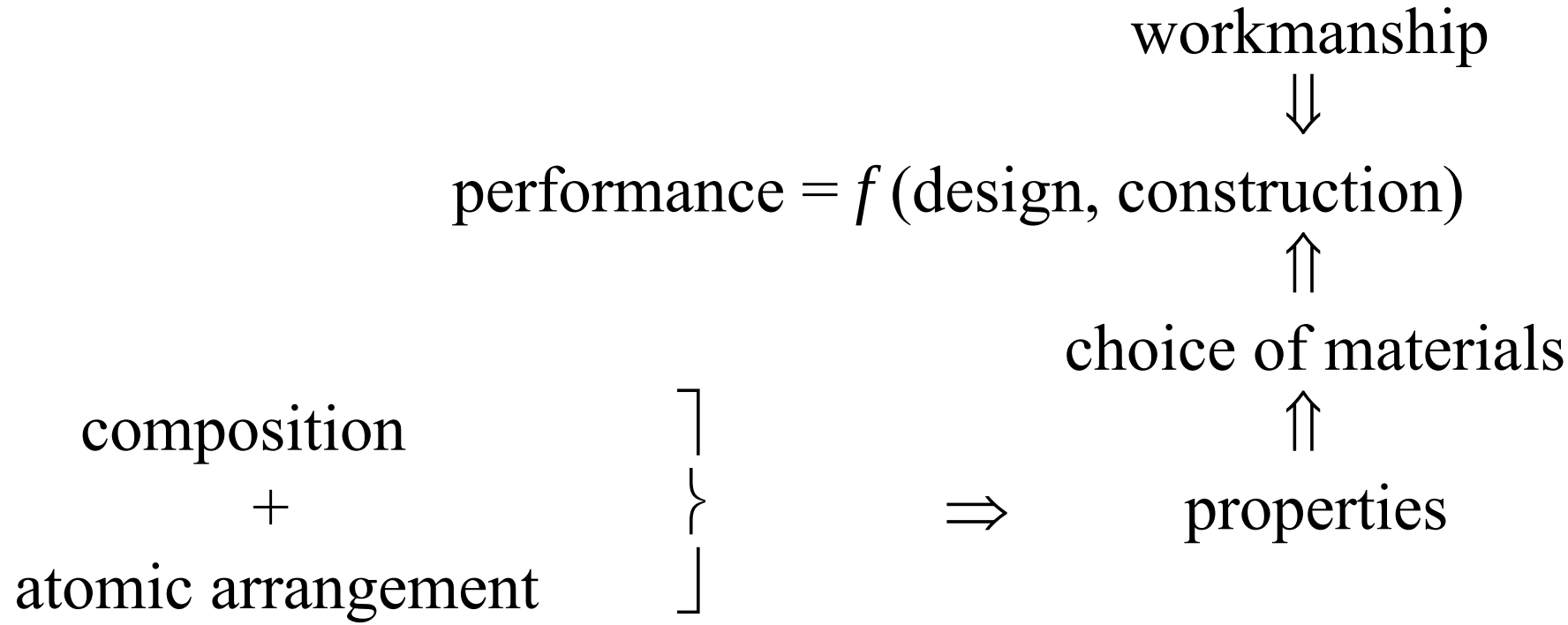
☞ molten salts & polymers

applied research:

environmentally sound technologies for extraction, refining, and recycling of metals

lithium solid polymer batteries

production of oxygen, structural metals, and photovoltaic materials from lunar & Martian soils



the thesis of 3.091:
electronic structure of the elements holds the key to understanding

☞ syllabus

3.091 Syllabus

- 1. General Principles of Chemistry

- 2. Solid State Chemistry:
  Basic Concepts and Applications

3.091 Introduction to Solid State Chemistry
Fall Term 2004

Lecturer Professor Donald R. Sadoway

Text ***Chemistry: Structure and Dynamics***, 2nd Edition, J.N. Spencer, G.M. Bodner, and L.H. Rickard, Wiley, New York, 2003 (3 volumes)

Lectures Monday, Wednesday, and Friday, 11:00-12:00 (L01)
Monday, Wednesday, and Friday, 1:00-2:00 (L02)

Recitations Sections meet on Tuesdays *and* Thursdays each week. See separate listing for times, instructors, and locations.
Students have been assigned to lecture and recitation sections by the Registrar. Movement between lecture and recitation sections is allowed only with permission which can be obtained by meeting with one of the Subject Administrators.

Underpopulated Sections

Section 21 TR 2
Section 32 TR 1
Section 33 TR 11

Complementary Subject STS.021 History, Society and Solid State Chemistry TR 11 CI-H

Homework Weekly. Distributed along with model solutions in recitation. One week later, in recitation, students will take a 10-minute quiz based on the subject matter of the homework. The scores on these weekly quizzes will count as the “homework” portion of the cumulative grade in the subject. All scores count -- no dropping of lowest score(s) from the average.

3.091 Homework No. 1

- assigned September 8

- tested September 14

from SBR Core Text:

Ch. 1 # 9, 39, 47-51, 62, 88

Ch. 2 # 83, 102, 123, 129, 173

- issued along with model solutions

Tests **#1** Wednesday, September 29, 11:05-11:55 (L01); 1:05 - 1:55 (L02).

#2 Wednesday, October 27, 11:05-11:55 (L01); 1:05 - 1:55 (L02).

#3 Wednesday, November 17, 11:05-11:55 (L01); 1:05 - 1:55 (L02).

permissible aids: periodic table, table of constants, one sheet of paper
calculator

FINAL EXAM: 3 hours. Time and location to be set by the Registrar and published by October 1. Final Exam Period is December 13 – 17. Do not plan to leave town until after your last final.

Grading Freshmen -- Pass/No Record
(Institute requirement for Pass is performance at C level or better)

Upperclassmen -- A, B, C, D, F

Final grade composition:

16.75% homework
16.75% each for three tests
33% final exam

Passing grade (C-level) = 50% absolute (no grading on a curve)

Academic Honesty

It is expected that students in 3.091 will maintain the highest standards of academic honesty. In particular, it is expected that in the course of taking a test or examination, students will not (1) accept information of any kind from others; (2) represent as their own the work of anyone else; or (3) use aids to memory other than those expressly permitted by the examiner. Following a test or examination, students will not try to deceive the teaching staff by misrepresenting or altering their previous work.

Departures from the above standards are contrary to fundamental principles of MIT and of the scientific community at large. Such departures are considered serious offenses for which disciplinary penalties, including suspension and expulsion, can be imposed by the Institute.

Classroom Behavior

To maintain a fertile learning environment in a lecture theater seating as many as 450 people, it is necessary for the instructor to expect adherence to certain rules of conduct. During lecture, students may not (1) hold conversations; (2) consume food or drink; (3) engage in disruptive behavior. Wireless communications devices must be silenced. Violations will not be tolerated.

3.091 Introduction to Solid-State Chemistry

Prereq: –

U (Fall, Spring)

5-0-7 CHEMISTRY

recipe for success:
venues for learning

lecture
recitation
reading
homework
weekly quizzes
monthly tests
final exam

recipe for success:
venues for learning

DRS

- lecture
- recitation
- reading
- homework
- weekly quizzes
- monthly tests
- final exam

recipe for success:
venues for learning

DRS	lecture
staff	recitation
	reading
	homework
	weekly quizzes
	monthly tests
	final exam

recipe for success:
venues for learning

DRS	lecture
staff	recitation
you	reading
	homework
	weekly quizzes
	monthly tests
	final exam

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venues for learning

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you	final exam

☞☞☞ partnership!!!

Education is what remains
when you have forgotten
all your schooling.

- Benjamin Franklin

today's lecture

taxonomy

classification

nomenclature

☞ *William Shakespeare*

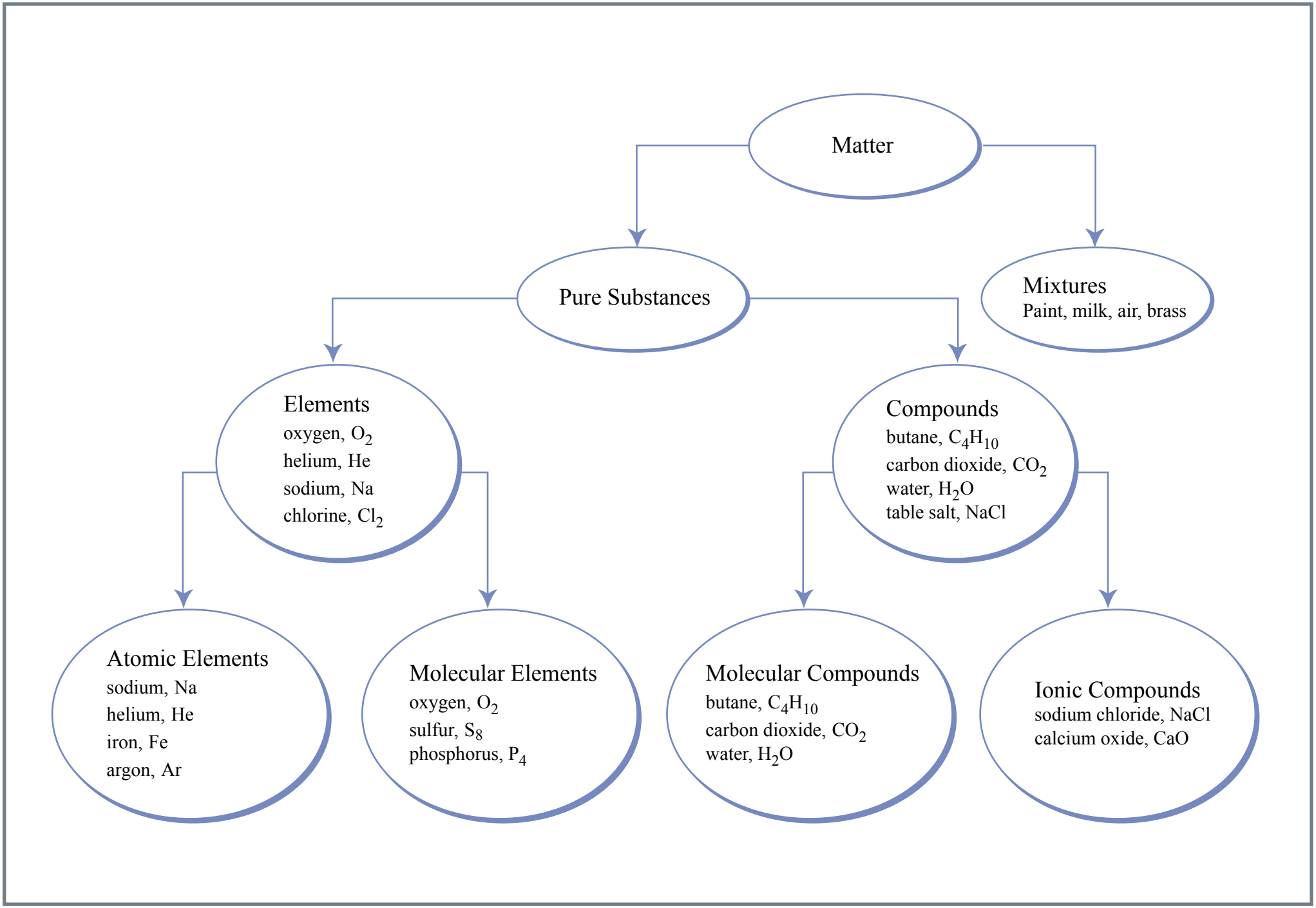

Figure by MIT OCW.

origins of chemistry

* ancient Egyptian hieroglyphs refer to ***khemeia:*** chemical processes for embalming the dead

* khemeia expanded to other chemical processes, especially, metals extraction

basic research:

electrochemistry in nonaqueous media

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applied research:

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origins of chemistry

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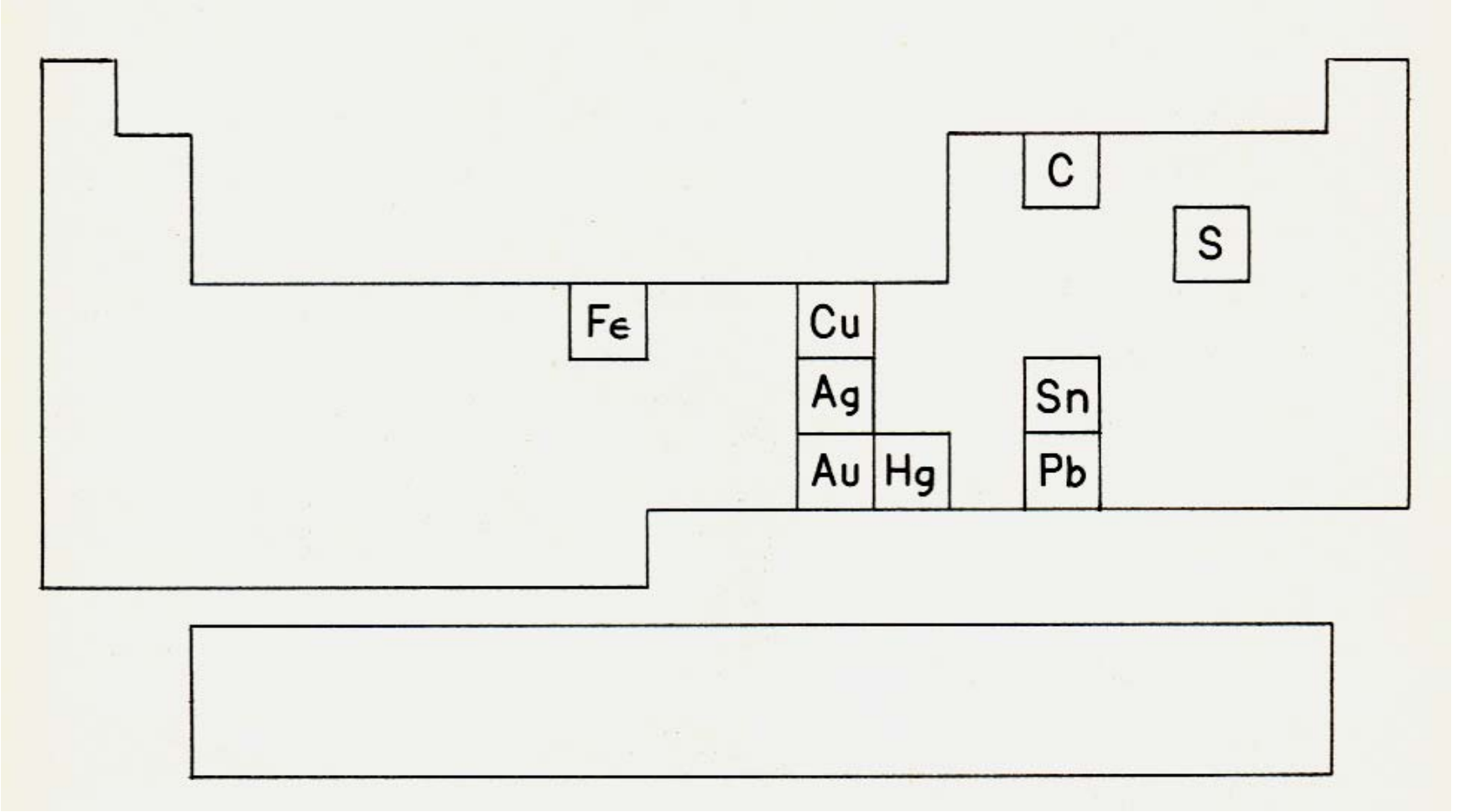
chemistry	astronomy
gold	the Sun
silver	the moon
copper	Venus
iron	Mars
tin	Jupiter
lead	Saturn
mercury	Mercury

~ 2400 years ago



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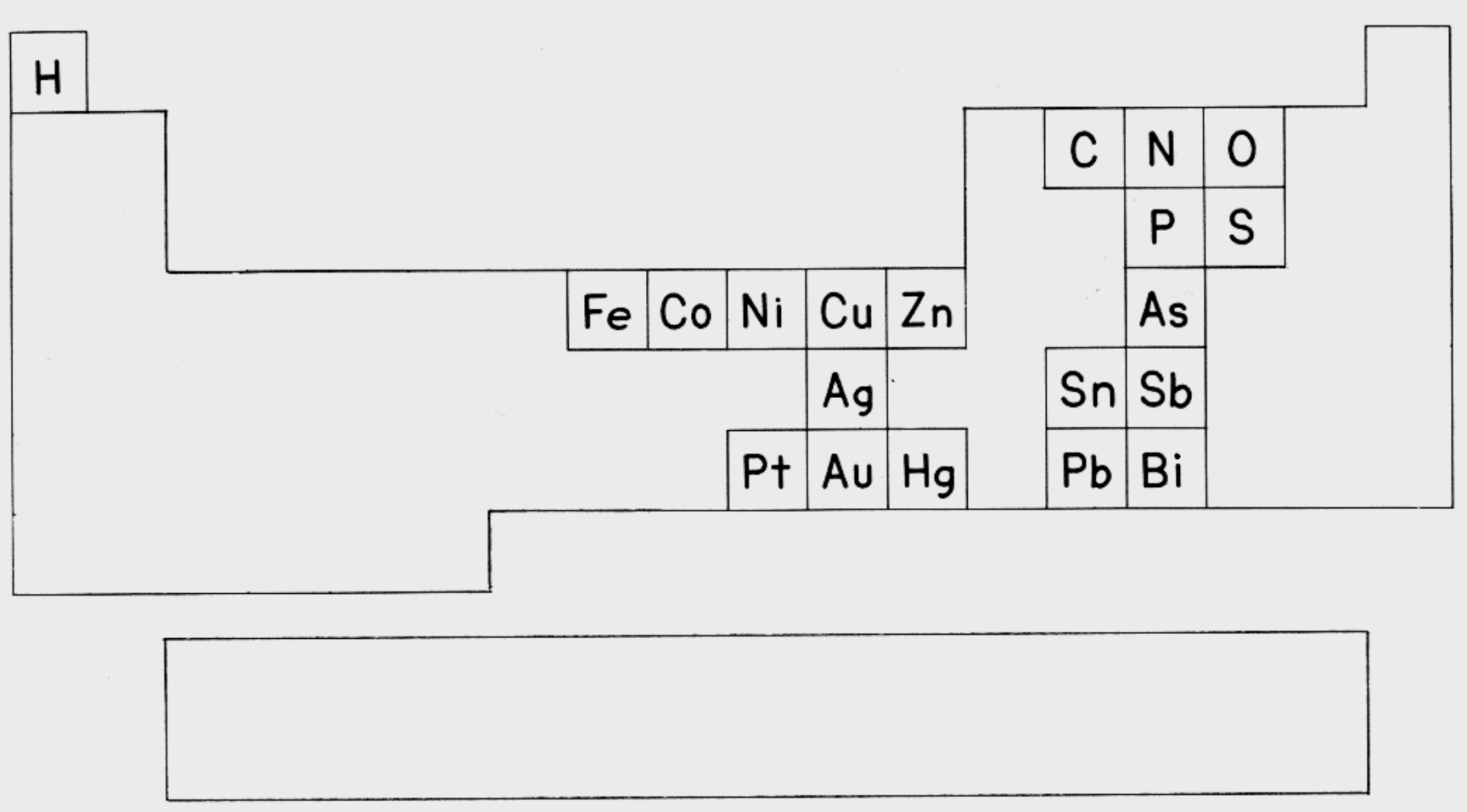

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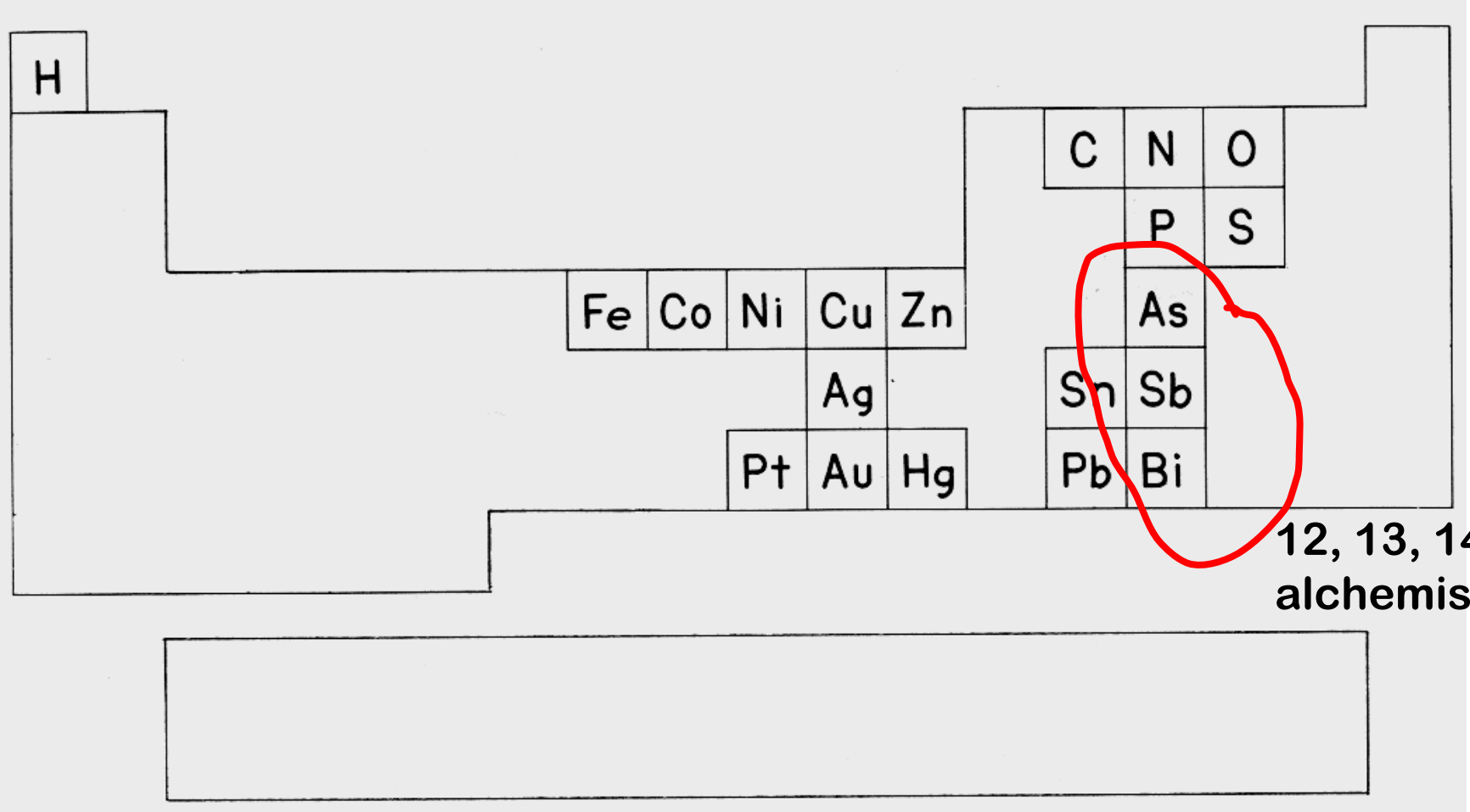
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12, 13, 14 C
alchemists

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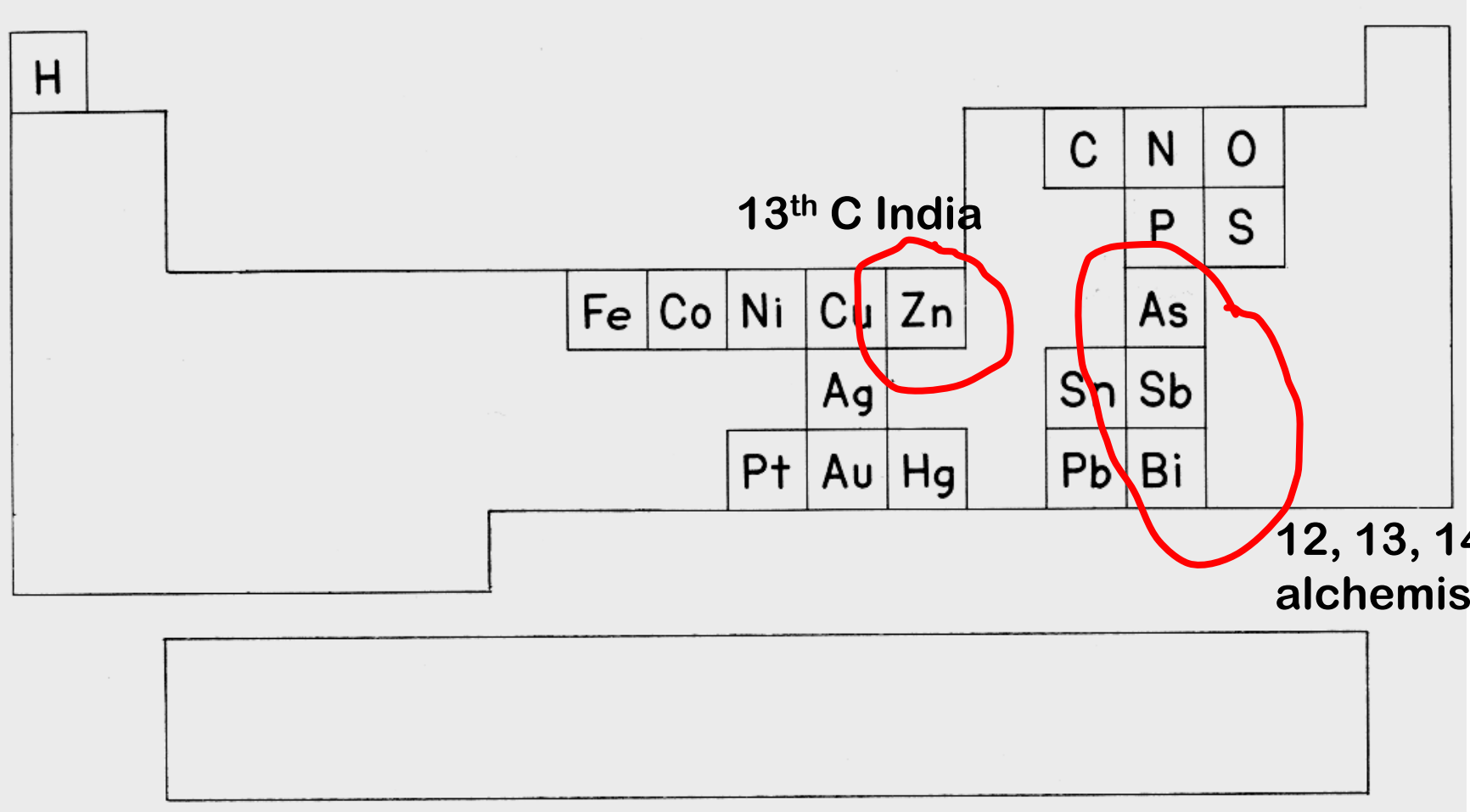
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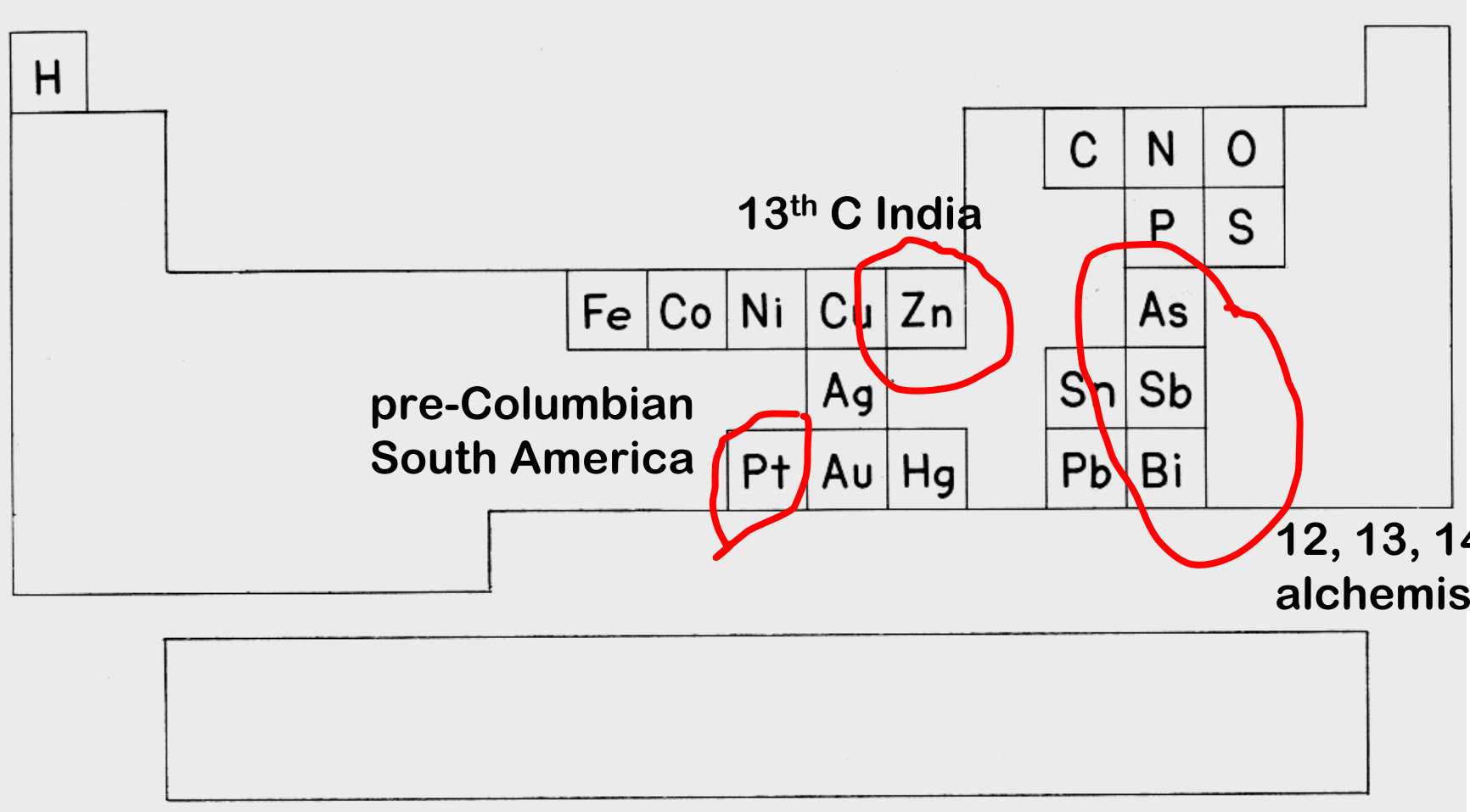
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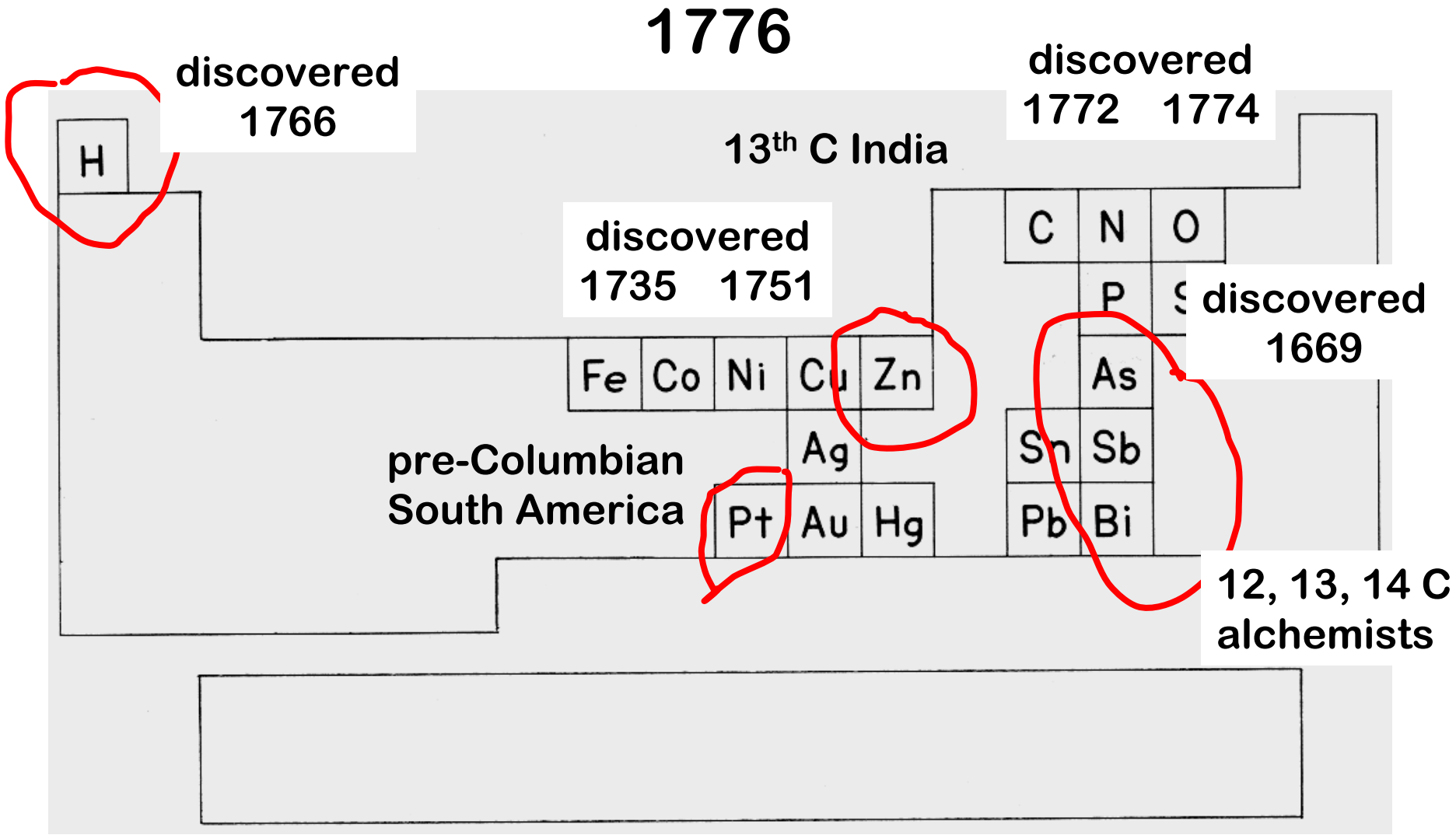
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pre-Columbian
South America
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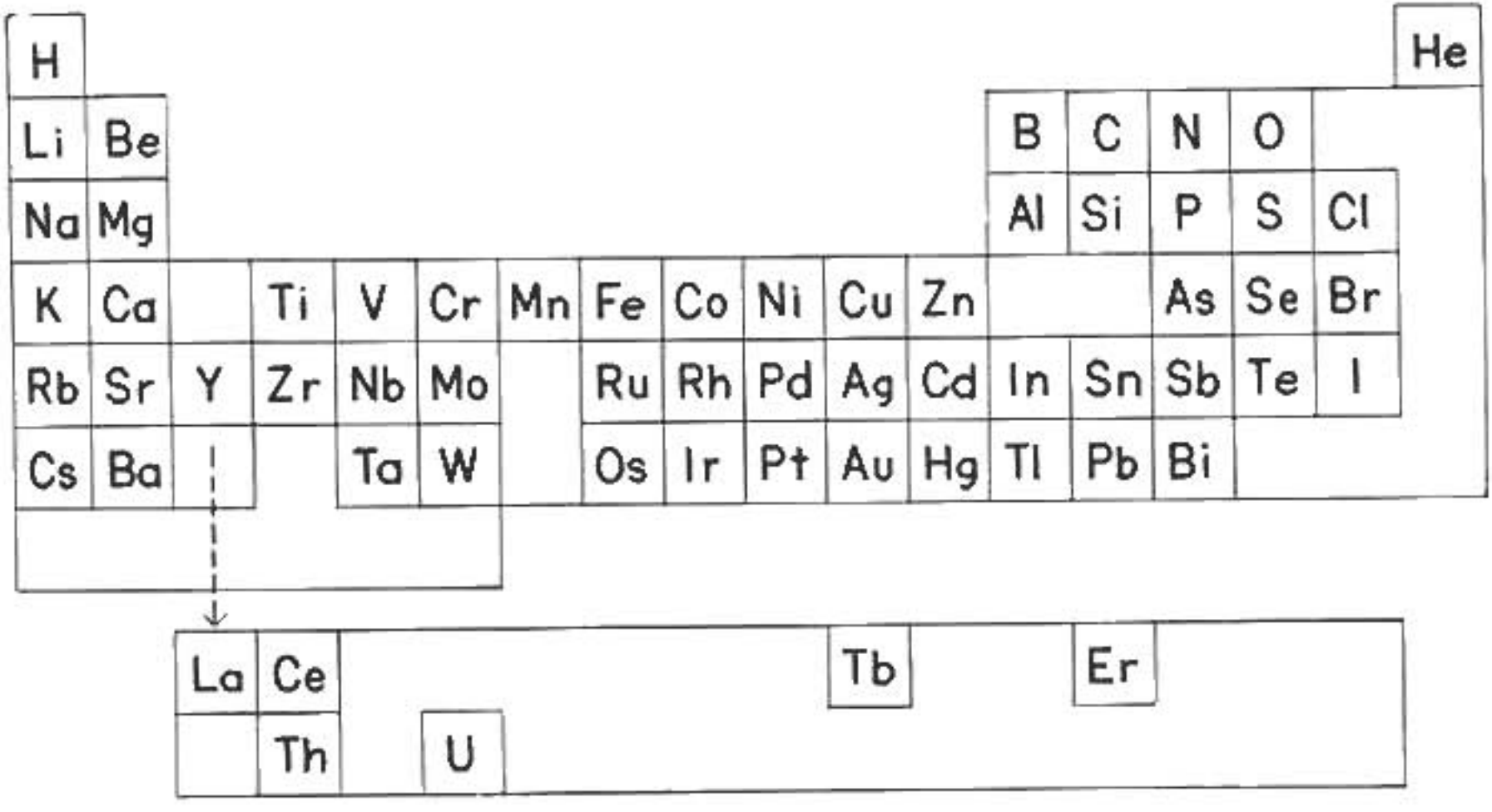
Pb Bi
12, 13, 14 C
alchemists

John Dalto
1803

other classifications:

* “triads” 1829, Döbereiner (Jena)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other classifications:

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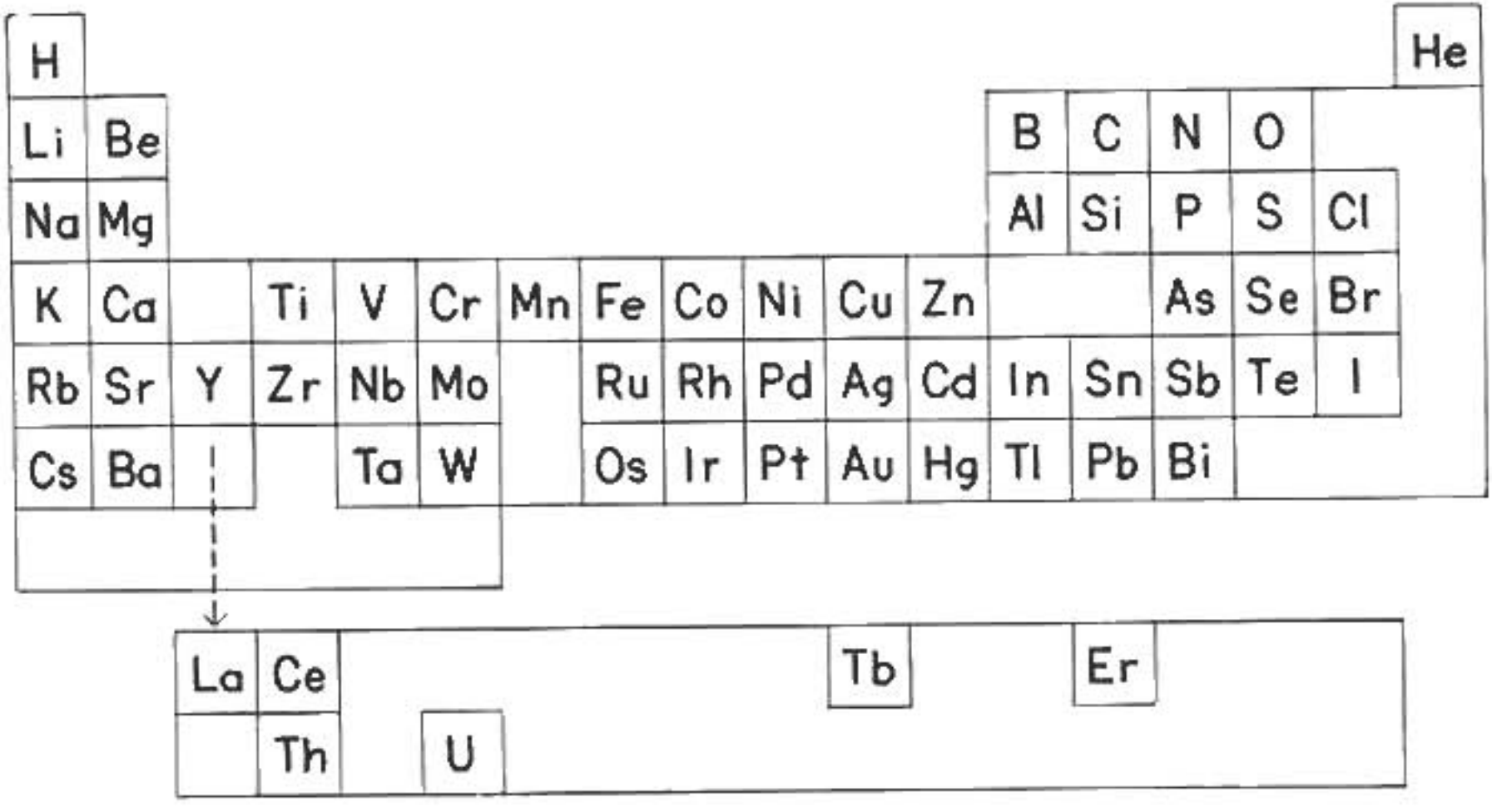
* “octaves” 1864, Newlands (London)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other classifications:

* “triads” 1829, Döbereiner (Jena)

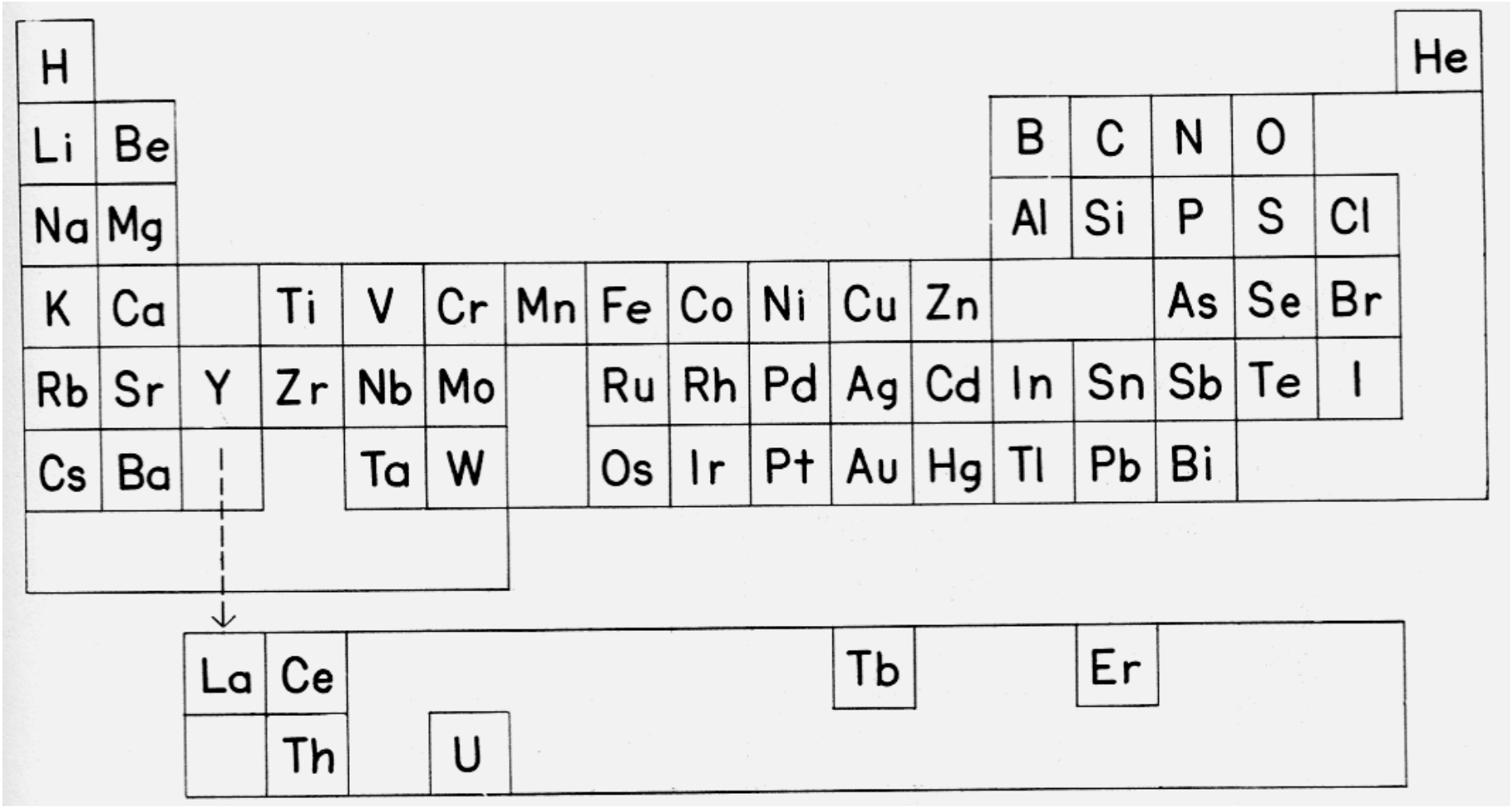
* “octaves” 1864, Newlands (London)

* “periodic table”

    1869, Mendeléef (St. Petersburg)

    1870, Meyer (Tübingen)

1869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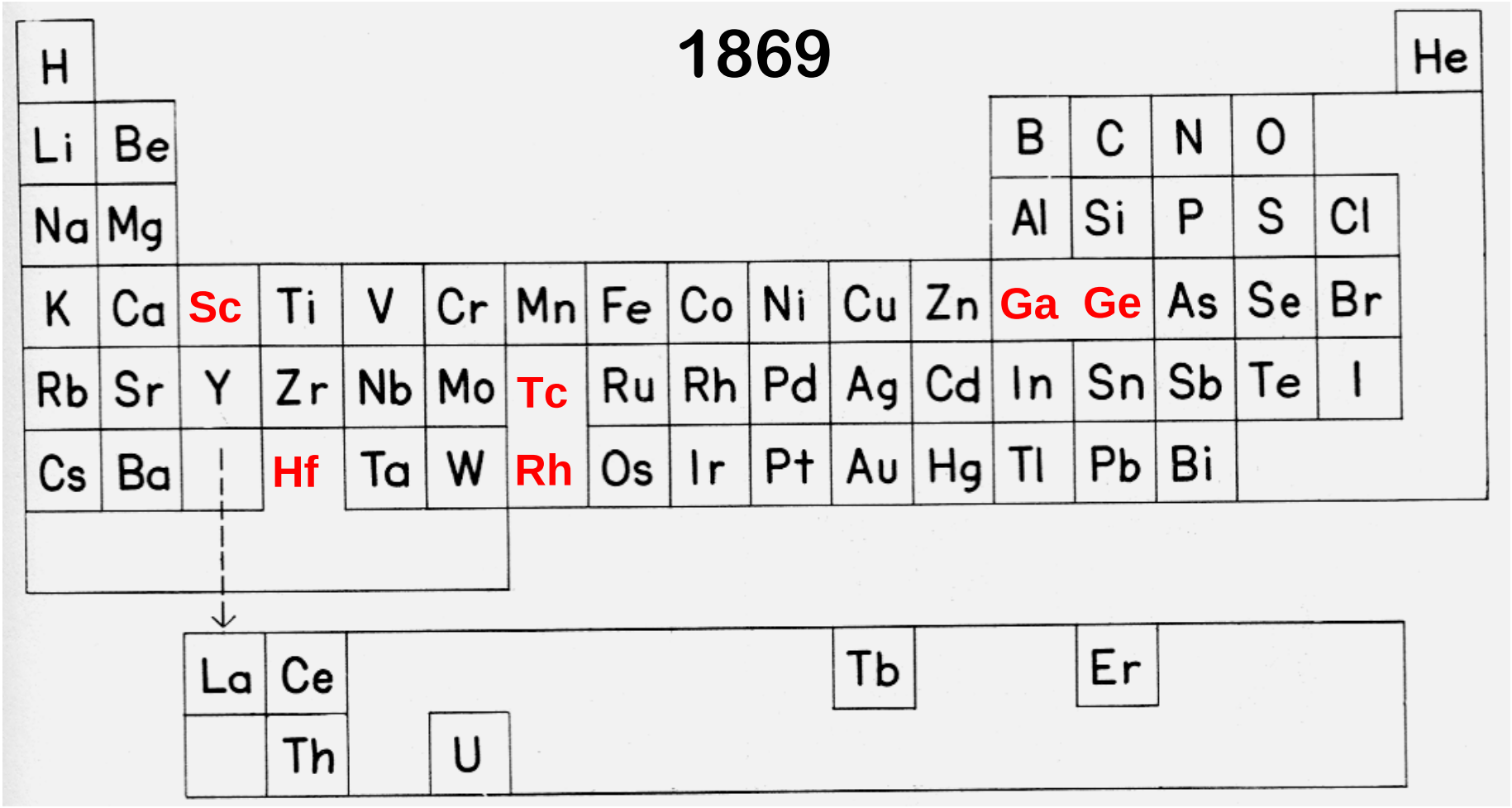

eka-boron	45	Sc	45.0
eka-aluminum	68	Ga	69.7
eka-silicon	72	Ge	72.6
eka-zirconium	180	Hf	178.5

Д. И. Менделеев (60-е годы).

но въ нихъ, мнѣ кажется, уже ясно выражается примѣнимость выставляемаго мною начала ко всей совокупности элементовъ, для которыхъ извѣстенъ съ достовѣрностію. На этотъ разъ я и желалъ преимущественно найдти общую систему элементовъ. Вотъ этотъ опытъ:

		Ti = 50	Zr = 90	? = 180.	
		V = 51	Nb = 94	Ta = 182.	
		Cr = 52	Mo = 96	W = 186.	
		Mn = 55	Rh = 104,4	Pt = 197,4	
		Fe = 56	Ru = 104,4	Ir = 198.	
		Ni = Co = 59	Pl = 106,6	Os = 199.	
H = 1		Cu = 63,4	Ag = 108	Hg = 200.	
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,4	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,5	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

а потому приходится въ разныхъ рядахъ имѣть разныя наименованія разностей, чего нѣтъ въ главныхъ числахъ предлагаемой таблицы. Имъ не придется предполагать при составленіи системы ни въ какомъ недостающемъ членѣ. То и другое мало выгодно. Мнѣ кажется проще, наиболѣе естественнымъ составить аналитическую систему (предлагаемая есть классификація), но и помнить для ея образованія не повсюду въ наиближайшихъ результатахъ. Слѣдующія два сопоставленія могутъ показать то разнообразіе сопоставленій, какое возможно при допущеніи основнаго начала, высказаннаго въ этой статьѣ.

Li	Na	K	Cu	Rb	Ag	Cs	—	Tl
7	23	39	63,4	85,4	108	133		204
Be	Mg	Ca	Zn	Sr	Cd	Ba	—	Pb
B	Al	—	—	—	Ur	—	—	Bi?
C	Si	Ti	—	Zr	Sn	—	—	—
N	P	V	As	Nb	Sb	—	Ta	—
O	S	—	Se	—	Te	—	W	—
F	Cl	—	Br	—	J	—	—	—
19	35,5	56	80	190	127	160	190	220

Д. И. Менделеев.

Портрет работы И. Е. Репина.