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RECENT ESTIMATES OF THE ABUNDANCES OF THE ELEMENTS IN THE EARTH'S CRUST

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By Michael Fleischer

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ABSTRACT

This is a compilation of estimates of the abundances of the elements, taken from nine papers published between 1924 and 1952. They are arranged in three tables: (1) weight percents of the 25 most abundant elements, (2) abundances of the first 92 elements arranged in order of atomic number, and (3) abundances of the first 92 elements arranged alphabetically.

INTRODUCTION

The U. S. Geological Survey receives many requests for information on the abundances of the elements. Data on this subject are scattered through the literature and are not always readily accessible. I have therefore assembled nine estimates of abundances of all the elements, published during the past 30 years and they are given in three tables: The first table gives the 25 most abundant elements, the second and third list the first 92 elements, arranged in the second table in order of atomic number and in the third in alphabetical order. The data are plotted in figures 1 and 2. No data are listed for the elements of atomic numbers 93 to 98, neptunium, plutonium, americium, curium, berkelium, and californium. Neptunium and plutonium have been shown to occur naturally in exceedingly small concentrations, probably less than 10^{-13} percent. It is not known at present whether the other elements listed above occur in nature; likewise there are no published data on the occurrence of the elements of atomic numbers 43, 61, 85, and 87—technetium, promethium, astatine, and francium.

It should be noted that the nine estimates are not strictly comparable. Three of them (nos. 2, 5, and 9) refer to abundances in igneous rocks only; that is, they ignore the sedimentary rocks and the oceans. This has very little effect on the data given for most elements because the igneous rocks are estimated to constitute 95 percent of the earth's crust down to a 10-mile depth; it does, however, have a marked effect on the estimates of hydrogen, oxygen, and chlorine which are so abundant in the oceans.

It is not practicable here to discuss the data in detail. It should be noted that since the estimates of column 9, tables 2 and 3, were made in 1924, advances in spectrographic methods of analysis have resulted in much higher estimates of the abundances of elements such as gallium, germanium, indium, and thallium, for which almost no quantitative determinations were available 25 years ago.

The methods by which the estimates were made are explained in detail in reference 9, also more briefly in references 1 and 2. It should be emphasized that many assumptions have to be made and that the accuracy of the figures given for the

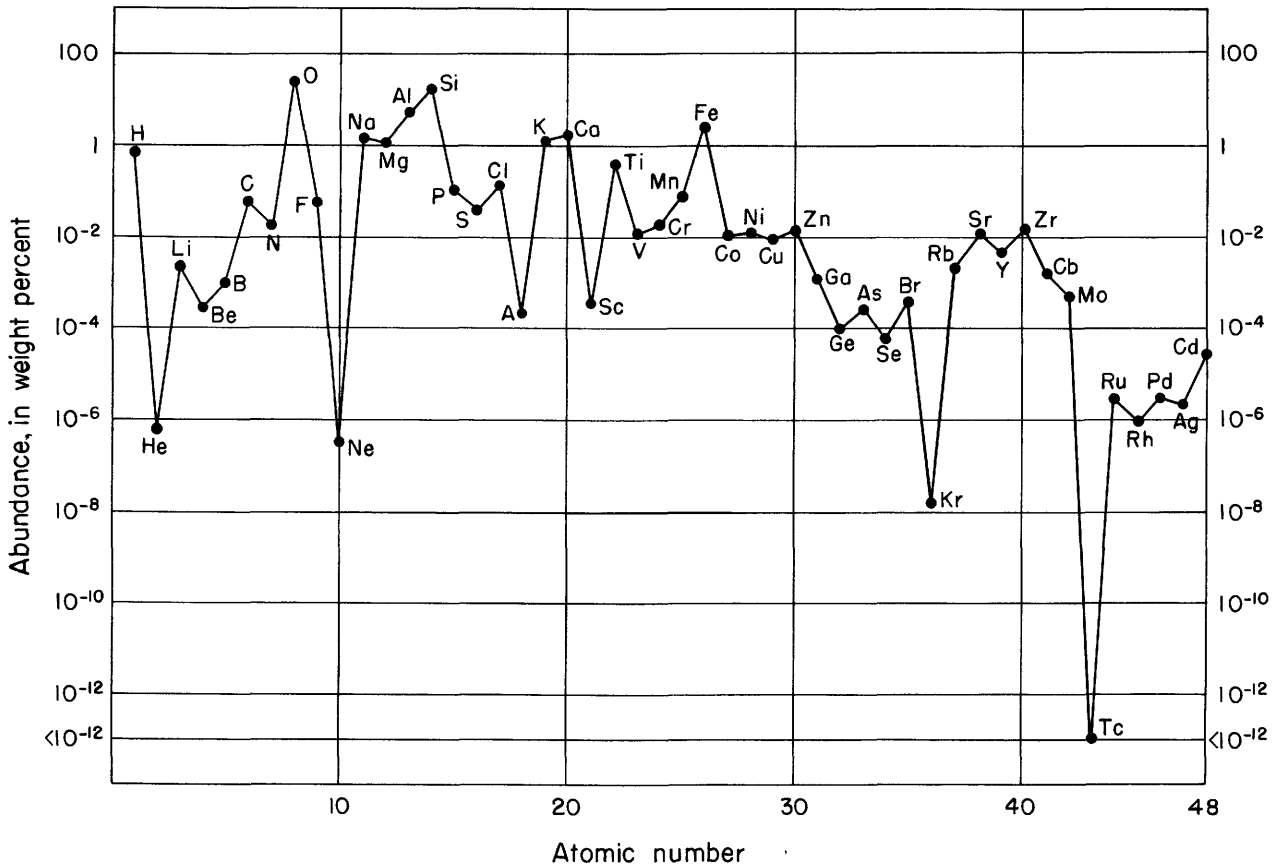

Figure 1.—Abundances of elements of atomic numbers 1 to 48.

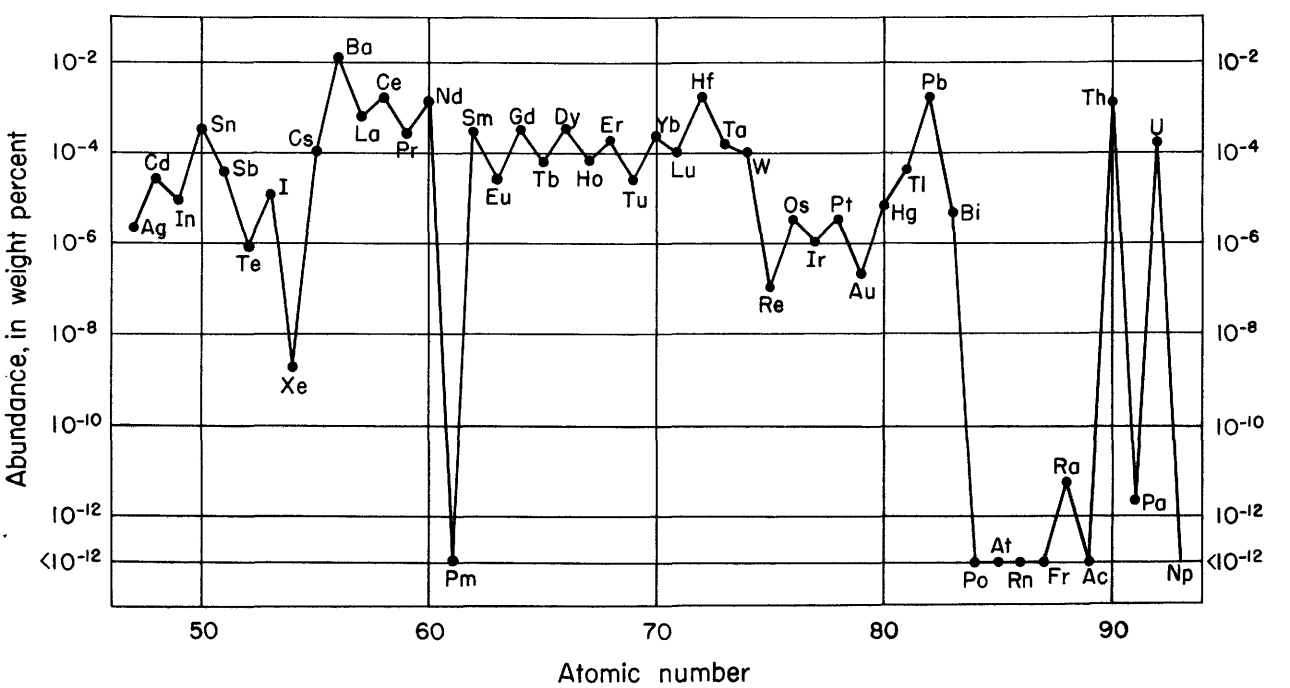

Figure 2.—Abundances of elements of atomic numbers 47 to 93.

Table 1.—Weight percents of the 25 most abundant elements in the earth's crust (Mason, 1952, p. 41).

	Element	Weight percent		Element	Weight percent
1	Oxygen-------	46.60	14	Carbon----	0.032
2	Silicon------	27.72	15	Chlorine--	.031
3	Aluminum-----	8.13			
4	Iron---------	5.00	16	Rubidium--	.031
5	Calcium------	3.63	17	Fluorine--	.030
			18	Strontium-	.030
6	Sodium-------	2.83	19	Barium----	.025
7	Potassium----	2.59	20	Zirconium-	.022
8	Magnesium----	2.09			
9	Titanium-----	.44	21	Chromium--	.020
10	Hydrogen-----	.14	22	Vanadium--	.015
	Total of		23	Zinc------	.013
	first 10--	99.17	24	Nickel----	.008
			25	Copper----	.007
11	Phosphorus---	.118			
12	Manganese----	.100		Total of	
13	Sulfur-------	.052		all 25---	99.70

various elements varies greatly. For example, the figures given for antimony and bismuth are based on very few determinations and are to be regarded as good guesses; in contrast, the figures for niobium and tantalum are based on many careful analyses. However, considering the many uncertainties involved, it is likely that only 2 significant figures for the more abundant elements (such as silicon) and only 1 significant figure for the less abundant elements (such as samarium) are meaningful.

For further details on the individual elements and on methods of estimating abundances, references 1 to 9 should be consulted, especially 2 and 9; for data on the oceans, the reader is referred to "The oceans, their physics, chemistry, and general biology, " by H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, Prentice-Hall, New York, 1087 p. (1946); and for data on the relative abundances of the isotopes of the elements to "Relative isotopic abundances of the elements, " by K. T. Bainbridge and A. O. Nier, National Research Council Preliminary Report 9, 59 p. (1950).

REFERENCES FOR TABLES 2 AND 3

Column no.

1 Mason, Brian, 1952, Principles of geochemistry, 276 p., New York, John Wiley and Sons. (For crust.)

2 Rankama, K., and Sahama, T. G., 1950, Geochemistry, p. 39-40, The University of Chicago Press. (For igneous rocks.)

3 Polanski, A., 1948, A new essay of evaluation of the chemical composition of the earth: Soc. des Amis des Sci. Lettres de Poznan, Ser. B, v. 9, p. 39-40. (For 35 km-crust.)

4 Anderson, J. S., 1945, Chemistry of the earth: Royal Soc. New South Wales Jour. and Proc., v. 76, p. 329-345. (For crust.)

5 Goldschmidt, V. M., 1937, The laws of the geochemical distribution of the elements: IX. The abundance of the elements: Norske vidensk.-akad. Oslo, Mat.-Nat. Klasse, no. 4, p. 1-148 [in German]. (For igneous rocks.)

6 Fersman, A. E., 1933, Geokhimia, Leningrad [in Russian], quoted by Wells, R. C., 1937, U. S. Geol. Survey Bull. 878, p. 4-5. (For 10-mile crust.)

7 Schneiderhöhn, H., 1934, Die ausnutzungsmöglichkeiten der deutschen Erzlagerstatten: Metallwirtschaft 13, p. 151-157. (For 16 km-crust.)

8 Berg, G., 1929, Vorkommen und Geochemie der Mineralischen Rohstoffe, p. 11, Leipzig.

9 Clarke, F. W., and Washington, H. S., 1924, The composition of the earth's crust: U. S. Geol. Survey Prof. Paper 127, p. 1-117. (For igneous rocks.)

Table 2.—Estimates of abundance of the elements in the earth's crust, arranged in order of atomic number

[Column numbers indicate references on page 3]

Atomic no.	Element	Composition in weight percent								
		1	2	3	4	5	6	7	8	9
1.	Hydrogen	0.14	Present----	0.44	0.87	---	1.00	0.87	0.87	0.13
2.	Helium	$1x10^{-7}$	$3x10^{-7}$	$7x10^{-8}$	$8x10^{-7}$	---	$1x10^{-6}$	$8x10^{-7}$	$8x10^{-7}$	---
3.	Lithium	.0065	0.0065	.0065	.004	0.0065	.005	.004	.004	.004
4.	Beryllium	.0006	.0006	.0006	.0005	.0006	.003	.0005	.0005	.001
5.	Boron	.0003	.0003	.00056	.001	.0003	.01	.001	.001	.001
6.	Carbon	.032	.032	.055	.08	.032	.35	.08	.08	.032
7.	Nitrogen	.0046	.00463	.0079	.030	---	.04	.030	.030	---
8.	Oxygen	46.60	46.60	47.9	49.5	46.60	49.13	49.5	49.5	46.59
9.	Fluorine	.030	.06-.09	.029	.027	.03	.08	.026	.027	.030
10.	Neon	---	$7x10^{-9}$	$1.2x10^{-7}$	$5x10^{-7}$	---	$5x10^{-7}$	$5x10^{-7}$	$5x10^{-7}$	---
11.	Sodium	2.83	2.83	2.76	2.63	2.83	2.40	2.63	2.63	2.85
12.	Magnesium	2.09	2.09	2.04	1.93	2.09	2.35	1.93	1.93	2.09
13.	Aluminum	8.13	8.13	7.9	7.5	8.13	7.45	7.5	7.5	8.13
14.	Silicon	27.72	27.72	27.0	25.7	27.72	26.00	25.3	25.7	27.72
15.	Phosphorus	.118	.118	.78	.12	.080	.12	.12	.12	.13
16.	Sulfur	.052	.052	.55	.06	.052	.10	.06	.06	.052
17.	Chlorine	.0314	.0314	.1	.19	.048	.20	.19	.19	.048
18.	Argon	$4x10^{-6}$	$4x10^{-6}$	.0013	$3.5x10^{-4}$	---	.0004	.00035	.00035	$nx10^{-4}$
19.	Potassium	2.59	2.59	2.52	2.40	2.59	2.35	2.40	2.40	2.60
20.	Calcium	3.63	3.63	3.54	3.39	3.63	3.25	3.39	3.39	3.63
21.	Scandium	.0005	.0005	.0005	.0006	.0005	.0006	.0006	.000075	$nx10^{-5}$
22.	Titanium	.44	.44	4.3	.58	.44	.61	.63	.58	.63
23.	Vanadium	.015	.015	.15	.016	.015	.02	.018	.016	.017
24.	Chromium	.020	.02	.019	.033	.02	.03	.038	.033	.037
25.	Manganese	.100	.100	.097	.09	.10	.10	.09	.09	.10
26.	Iron	5.00	5.00	4.87	4.7	5.00	4.20	5.08	4.7	5.01
27.	Cobalt	.0023	.0023	.004	.0012	.004	.002	.0012	.0012	.001
28.	Nickel	.008	.008	.01	.018	.01	.02	.018	.018	.020
29.	Copper	.007	.007	.01	.010	.01	.01	.010	.010	.010
30.	Zinc	.0132	.0132	.004	.02	.004	.02	.017	.0045	.004
31.	Gallium	.0015	.0015	.015	.00002	.0015	.001	.00005	$1x10^{-7}$	$nx10^{-9}$
32.	Germanium	.0007	.0007	.0007	.0001	.0007	.0001	.0001	$2x10^{-8}$	$nx10^{-9}$
33.	Arsenic	.0005	.0005	.0005	.00045	.0005	.0005	.00048	.00045	$nx10^{-4}$
34.	Selenium	$9x10^{-6}$	$9x10^{-6}$	.00001	.00008	$9x10^{-6}$	.00008	.00008	$3x10^{-6}$	$nx10^{-6}$
35.	Bromine	.00016	.000162	.0004	.0006	---	.001	.0006	.0006	$nx10^{-4}$
36.	Krypton	---	---	$3x10^{-8}$	$1.9x10^{-8}$	---	$2x10^{-8}$	$2x10^{-6}$	$1.9x10^{-8}$	---
37.	Rubidium	.031	.031	.029	.0033	.031	.008	.0035	.0033	$.000_n$
38.	Strontium	.030	.03	.015	.017	.015	.035	.020	.020	.019
39.	Yttrium	.0028	.00281	.0028	.007	.0028	.005	.007	.007	[b] .015
40.	Zirconium	.022	.022	.021	.023	.022	.025	.023	.023	[c] .026
41.	Niobium	.0024	.0024	.002	.00006	.002	.000032	.00006	.00006	.003
42.	Molybdenum	.0015	.00025-.0015	.0015	.00075	.0015	.001	.00075	.00075	$nx10^{-4}$
43.	Technetium	---	Presence unsettled.	---	$1x10^{-7}$	---	$1x10^{-7}$	---	---	---
44.	Ruthenium	$1x10^{-9}$(?)	Present----	$2x10^{-6}$	$5x10^{-6}$	---	$5x10^{-6}$	$4x10^{-6}$	$3.6x10^{-11}$	$nx10^{-9}$
45.	Rhodium	$1x10^{-9}$	$1x10^{-7}$	$1x10^{-7}$	$1x10^{-6}$	$1x10^{-7}$	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-10}$	$nx10^{-9}$
46.	Palladium	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	$5x10^{-6}$	$1x10^{-6}$	$8x10^{-6}$	$5x10^{-6}$	$6x10^{-9}$	$nx10^{-9}$
47.	Silver	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$4x10^{-6}$	$1x10^{-5}$	$1x10^{-5}$	$6x10^{-6}$	$4x10^{-6}$	$nx10^{-6}$

48.	Cadmium	1.5×10^{-5}	1.5×10^{-5}	5×10^{-5}	1×10^{-5}	5×10^{-5}	5×10^{-4}	4×10^{-5}	1×10^{-5}	$n\times10^{-5}$
49.	Indium	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	9×10^{-7}	$n\times10^{-9}$
50.	Tin	.004	.0040	.004	.0006	.004	.0006	.0006	.0006	$n\times10^{-4}$
51.	Antimony	1×10^{-4}(?)	.0001	.0001	3×10^{-5}	.0001	5×10^{-5}	3×10^{-5}	3×10^{-5}	$n\times10^{-5}$
52.	Tellurium	2×10^{-7}(?)	1.8×10^{-7}	2×10^{-7}	1×10^{-6}	2×10^{-7}	1×10^{-6}	1×10^{-6}	6×10^{-8}	$n\times10^{-7}$
53.	Iodine	3×10^{-5}	3×10^{-5}	3×10^{-5}	7×10^{-6}	3×10^{-5}	1×10^{-4}	7×10^{-6}	7×10^{-6}	$n\times10^{-5}$
54.	Xenon	---	---	4.6×10^{-9}	2.9×10^{-9}	---	3×10^{-9}	3×10^{-9}	2.9×10^{-9}	---
55.	Cesium	.0007	.0007	.0007	.00007	.0007	.0006	---	7×10^{-5}	$n\times10^{-5}$
56.	Barium	.025	.025	.024	.04	.025	.05	.04	.04	.050
57.	Lanthanum	.0018	.00183	.0018	.0005	.0018	.00065	.00045	.0005	---
58.	Cerium	.0046	.00461	.0046	.0022	.0046	.0029	.002	.0022	---
59.	Praseodymium	.00055	.000553	.00055	.00035	.00055	.00045	.00035	.00035	---
60.	Neodymium	.0024	.00239	.0024	.0012	.0024	.00175	.0012	.0012	---
61.	Promethium	---	---	---	1×10^{-5}	---	---	---	---	---
62.	Samarium	.00065	.000647	.00064	.0005	.0006	.0007	.00045	.0005	---
63.	Europium	.00011	.000106	.00011	.000014	.0001	.00002	.000015	.000014	---
64.	Gadolinium	.00064	.000636	.00064	.0005	.0006	.00075	.00045	.005	---
65.	Terbium	9×10^{-5}	9.1×10^{-5}	9×10^{-5}	7×10^{-5}	9×10^{-5}	1×10^{-4}	7×10^{-5}	7×10^{-5}	---
66.	Dysprosium	.00045	.000447	.00045	.0005	.00045	.00075	.00045	.0005	---
67.	Holmium	.00012	.000115	.00011	.00007	.0001	.0001	.00007	.00007	---
68.	Erbium	.00025	.000247	.00025	.0004	.00025	.00065	.0004	.0004	---
69.	Thulium	2×10^{-5}	2×10^{-5}	2×10^{-5}	7×10^{-5}	2×10^{-5}	1×10^{-4}	7×10^{-5}	7×10^{-5}	---
70.	Ytterbium	.00027	.000266	.00027	.0005	.0003	.0008	.00035	.0005	---
71.	Lutetium	8×10^{-5}	7.5×10^{-5}	7.5×10^{-5}	.0001	8×10^{-5}	.000175	9×10^{-5}	.0001	---
72.	Hafnium	.00045	.00045	.00045	.0025	.00045	.0004	.0025	.0025	.003
73.	Tantalum	.00021	.00021	.00021	2×10^{-5}	.0015	2.4×10^{-5}	2×10^{-5}	2×10^{-5}	---
74.	Tungsten	.0069	.00015-.0069	.0069	.005	.0069	.0009	.005	.005	.005
75.	Rhenium	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	---	---
76.	Osmium	1×10^{-7}(?)	Present-----	1×10^{-6}	5×10^{-6}	---	5×10^{-6}	4×10^{-6}	9×10^{-10}	$n\times10^{-8}$
77.	Iridium	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-6}	1×10^{-7}	1×10^{-6}	2×10^{-6}	5×10^{-10}	$n\times10^{-8}$
78.	Platinum	5×10^{-7}	5×10^{-7}	5×10^{-7}	5×10^{-6}	5×10^{-7}	5×10^{-6}	5×10^{-6}	1.2×10^{-8}	$n\times10^{-7}$
79.	Gold	5×10^{-7}	5×10^{-7}	5×10^{-7}	1.5×10^{-7}	5×10^{-7} [d]	5×10^{-7}(?)	6×10^{-7}	1.5×10^{-7}	$n\times10^{-7}$
80.	Mercury	5×10^{-5}	7.7×10^{-6}-5×10^{-5}	5×10^{-5}	3×10^{-6}	5×10^{-5}	1×10^{-4}	3×10^{-6}	3×10^{-6}	$n\times10^{-5}$
81.	Thallium	6×10^{-5}	.00003-.0003	3×10^{-5}	1×10^{-5}	3×10^{-5}	1×10^{-5}	1×10^{-5}	8×10^{-8}	$n\times10^{-8}$
82.	Lead	.0016	.0016	.0016	.002	.0016	.0016	.003	.002	.002
83.	Bismuth	2×10^{-5}	2×10^{-5}	2×10^{-5}	3×10^{-6}	2×10^{-5}	1×10^{-5}	3×10^{-6}	3×10^{-6}	$n\times10^{-6}$
84.	Polonium	---	3×10^{-14}	1.4×10^{-14}	1.4×10^{-15}	3×10^{-14}	5×10^{-6}	---	---	---
85.	Astatine (no data).									
86.	Radon	---	Present-----	5×10^{-16}	4×10^{-17}	---	1.2×10^{-15}	---	---	---
87.	Francium (no data).									
88.	Radium	---	1.3×10^{-10}	6.6×10^{-11}	7×10^{-12}	1.3×10^{-10}	3×10^{-10}	1.4×10^{-10}	7×10^{-12}	$n\times10^{-10}$
89.	Actinium	---	3×10^{-14}	2.6×10^{-14}	2.3×10^{-14}	3×10^{-14}	---	---	---	---
90.	Thorium	.0012	.00115	.00073	.002	.0012	.002	.0012	.002	.002
91.	Protactinium	---	8×10^{-11}	2.4×10^{-11}	2.6×10^{-12}	8×10^{-11}	7×10^{-11}	---	---	---
92.	Uranium	.0004	.0004	.0002	.00002	.0004	.0009	.00042	.00002	.008

[a] Some of these figures appear to be one order of magnitude too high, perhaps because of misplaced decimal points.

[b] Yttrium plus cerium plus all other rare earths.

[c] Niobium plus tantalum.

[d] Value is misquoted in Wells.

Table 3.—Estimates of abundances of the elements in the earth's crust, arranged alphabetically

[Column numbers indicate references on page 3]

Element	Composition in weight percent								
	1	2	[a] 3	4	5	6	7	8	9
Actinium	---	$3x10^{-14}$	$2.6x10^{-14}$	$2.3x10^{-14}$	$3x10^{-14}$	---	---	---	---
Aluminum	8.13	8.13	7.9	7.5	8.13	7.45	7.5	7.5	8.13
Antimony	.0001(?)	.0001	.0001	$3x10^{-5}$	.0001	$5x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$	$nx10^{-5}$
Argon	$4x10^{-6}$	$4x10^{-6}$	.0013	$3.5x10^{-4}$	---	.0004	.00035	.00035	$nx10^{-4}$
Arsenic	.0005	.0005	.0005	.00045	.0005	.0005	.00048	.00045	$nx10^{-4}$
Barium	.025	.025	.024	.04	.025	.05	.04	.04	.050
Beryllium	.0006	.0006	.0006	.0005	.0006	.003	.0005	.0005	.001
Bismuth	$2x10^{-5}$	$2x10^{-5}$	$2x10^{-5}$	$3x10^{-6}$	$2x10^{-5}$	$1x10^{-5}$	$3x10^{-6}$	$3x10^{-6}$	$nx10^{-6}$
Boron	.0003	.0003	.00056	.001	.0003	.01	.001	.001	.001
Bromine	.00016	.000162	.0004	.0006	---	.001	.0006	.0006	$nx10^{-4}$
Cadmium	$1.5x10^{-5}$	$1.5x10^{-5}$	$5x10^{-5}$	$1x10^{-5}$	$5x10^{-5}$	$5x10^{-4}$	$4x10^{-5}$	$1x10^{-5}$	$nx10^{-5}$
Calcium	3.63	3.63	3.54	3.39	3.63	3.25	3.39	3.39	3.63
Carbon	.032	.032	.055	.08	.032	.35	.08	.08	.032
Cerium	.0046	.00461	.0046	.0022	.0046	.0029	.002	.0022	---
Cesium	.0007	.0007	.0007	.00007	.0007	.0005	---	$7x10^{-5}$	$nx10^{-5}$
Chlorine	.0314	.0314	.1	.19	.048	.20	.19	.19	.048
Chromium	.020	.02	.019	.033	.02	.03	.038	.033	.037
Cobalt	.0023	.0023	.004	.0012	.004	.002	.0012	.0012	.001
Columbium (see niobium).									
Copper	.007	.007	.01	.010	.01	.01	.010	.010	.010
Dysprosium	.00045	.000447	.00045	.0005	.00045	.00075	.00045	.0005	---
Erbium	.00025	.000247	.00025	.0004	.00025	.00065	.0004	.0004	---
Europium	.00011	.000106	.00011	.000014	.0001	.00002	.000015	.000014	---
Fluorine	.03	.06-.09	.029	.027	.03	.08	.026	.027	.030
Gadolinium	.00064	.000636	.00064	.0005	.0006	.00075	.00045	.0005	---
Gallium	.0015	.0015	.015	.00002	.0015	.001	.00005	$1x10^{-7}$	$nx10^{-9}$
Germanium	.0007	.0007	.0007	.0001	.0007	.0001	.0001	$2x10^{-8}$	$nx10^{-9}$
Gold	$5x10^{-7}$	$5x10^{-7}$	$5x10^{-7}$	$1.5x10^{-7}$	$5x10^{-7}$	[b] $5x10^{-7}$	$6x10^{-7}$	$1.5x10^{-7}$	$nx10^{-7}$
Hafnium	.00045	.00045	.00045	.0025	.00045	.0004	.0025	.0025	.003
Helium	$3x10^{-7}$	$3x10^{-7}$	$7x10^{-8}$	$8x10^{-7}$	---	$1x10^{-6}$	$8x10^{-7}$	$8x10^{-7}$	---
Holminum	.00012	.000115	.00011	.00007	.0001	.0001	.00007	.00007	---
Hydrogen	.14	Present-----	.44	.87	---	1.00	.87	.87	.13
Indium	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$9x10^{-7}$	$nx10^{-9}$
Iodine	$3x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$	$7x10^{-6}$	$3x10^{-5}$	$1x10^{-4}$	$7x10^{-6}$	$7x10^{-6}$	$nx10^{-5}$
Iridium	$1x10^{-7}$	$1x10^{-7}$	$1x10^{-7}$	$1x10^{-6}$	$1x10^{-7}$	$1x10^{-6}$	$2x10^{-8}$	$5x10^{-10}$	$nx10^{-8}$
Iron	5.00	5.00	4.87	4.7	5.00	4.20	5.08	4.7	5.01
Krypton	---	---	$3x10^{-8}$	$1.9x10^{-8}$	---	$2x10^{-8}$	$2x10^{-8}$	$1.9x10^{-8}$	---
Lanthanum	.0018	.00183	.0018	.0005	.0018	.00065	.00045	.0005	---
Lead	.0016	.0016	.0016	.002	.0016	.0016	.003	.002	.002
Lithium	.0065	.0065	.0065	.004	.0065	.005	.004	.004	.004
Lutetium	$8x10^{-5}$	$7.5x10^{-5}$	$7.5x10^{-5}$	.0001	$8x10^{-5}$	.000175	$9x10^{-5}$	.0001	---
Magnesium	2.09	2.09	2.04	1.93	2.09	2.35	1.93	1.93	2.09
Manganese	.10	.100	.097	.09	.10	.10	.09	.09	.10
Mercury	$5x10^{-5}$	$7.7x10^{-6}$-$5x10^{-5}$	$5x10^{-5}$	$3x10^{-6}$	$5x10^{-5}$	$1x10^{-4}$	$3x10^{-6}$	$3x10^{-6}$	$nx10^{-5}$
Molybdenum	.0015	.00025-.0015	.0015	.00075	.0015	.001	.00075	.00075	$nx10^{-4}$
Neodymium	.0024	.00239	.0024	.0012	.0024	.00175	.0012	.0012	---
Neon	---	$7x10^{-9}$	$1.2x10^{-7}$	$5x10^{-7}$	---	$5x10^{-7}$	$5x10^{-7}$	$5x10^{-7}$	---
Nickel	.008	.008	.01	.018	.01	.02	.018	.018	.020

Niobium	.0024	.0024	.002	.00006	.002	.000032	.00006	.00006	[c] .003
Nitrogen	.0046	.00463	.0079	.030	---	.04	.030	.030	---
Osmium	1x10-7(?)	Present----	1x10-6	5x10-6	---	5x10-6	4x10-6	9x10-10	nx10-8
Oxygen	46.60	46.60	47.9	49.5	46.60	49.13	49.5	49.5	46.59
Palladium	1x10-6	1x10-6	1x10-6	5x10-6	1x10-6	8x10-6	5x10-6	6x10-9	nx10-9
Phosphorus	.118	.118	.78	.12	.080	.12	.12	.12	.13
Platinum	5x10-7	5x10-7	5x10-7	5x10-6	5x10-7	5x10-6	5x10-6	1.2x10-8	nx10-7
Polonium	---	3x10-14	1.4x10-14	1.4x10-15	3x10-14	5x10-6	---	---	---
Potassium	2.59	2.59	2.52	2.40	2.59	2.35	2.40	2.40	2.60
Praseodymium	.00055	.000553	.00055	.00035	.00055	.00045	.00035	.00035	---
Promethium	---	---	---	1x10-5	---	---	---	---	---
Protactinium	---	8x10-11	2.4x10-11	2.6x10-12	8x10-11	7x10-11	---	---	---
Radium	---	1.3x10-10	6.6x10-11	7x10-12	1.3x10-10	3x10-10	1.4x10-10	7x10-12	nx10-10
Radon	---	Present----	5x10-16	4x10-17	---	1.2x10-15	---	---	---
Rhenium	1x10-7	1x10-7	1x10-7	1x10-7	1x10-7	1x10-7	1x10-7	---	---
Rhodium	1x10-7	1x10-7	1x10-7	1x10-6	1x10-7	1x10-6	1x10-6	1x10-10	nx10-9
Rubidium	.031	.031	.029	.0033	.031	.008	.0035	.0033	.000n
Ruthenium	1x10-7(?)	Present----	2x10-6	5x10-6	---	5x10-6	4x10-6	3.6x10-11	nx10-9
Samarium	.00065	.000647	.00064	.0005	.0006	.0007	.00045	.0005	---
Scandium	.0005	.0005	.0005	.0006	.0005	.0006	.0006	.000075	nx10-5
Selenium	9x10-6	9x10-6	1x10-5	8x10-5	9x10-6	8x10-5	8x10-5	3x10-6	nx10-6
Silicon	27.72	27.72	27.0	25.7	27.72	26.00	25.3	25.7	27.72
Silver	1x10-5	1x10-5	1x10-5	4x10-6	1x10-5	1x10-5	6x10-6	4x10-6	nx10-6
Sodium	2.83	2.83	2.76	2.63	2.83	2.40	2.63	2.63	2.85
Strontium	.03	.03	.015	.017	.015	.035	.020	.020	.019
Sulfur	.052	.052	.55	.06	.052	.10	.06	.06	.052
Tantalum	.00021	.00021	.00021	2x10-5	.0015	2.4x10-5	2x10-5	2x10-5	---
Technetium	---	Presence unsettled.	---	1x10-7	---	1x10-7	---	---	---
Tellurium	2x10-7(?)	1.8x10-7	2x10-7	1x10-6	2x10-7	1x10-6	1x10-6	6x10-8	nx10-7
Terbium	9x10-5	9.1x10-5	9x10-5	7x10-5	9x10-5	1x10-4	7x10-5	7x10-5	---
Thallium	6x10-5	.00003-.0003	3x10-5	1x10-5	3x10-5	1x10-5	1x10-5	8x10-8	nx10-8
Thorium	.0012	.00115	.00073	.002	.0012	.002	.0012	.002	.002
Thulium	2x10-5	2x10-5	2x10-5	7x10-5	2x10-5	1x10-4	7x10-5	7x10-5	---
Tin	.004	.004	.004	.0006	.004	.0006	.0006	.0006	nx10-4
Titanium	.44	.44	4.3	.58	.44	.61	.63	.58	.63
Tungsten	.0069	.00015-.0069	.0069	.005	.0069	.0009	.005	.005	.005
Uranium	.0004	.0004	.0002	.00002	.0004	.0009	.00042	.00002	.08
Vanadium	.015	.015	.15	.016	.015	.02	.018	.016	.017
Xenon	---	---	4.6x10-9	2.9x10-9	---	3x10-9	3x10-9	2.9x10-9	---
Ytterbium	.00027	.000266	.00027	.0005	.0003	.0008	.00035	.0005	---
Yttrium	.0028	.00281	.0028	.007	.0028	.005	.007	.007	[d] .015
Zinc	.0132	.0132	.004	.02	.004	.02	.017	.0045	.004
Zirconium	.022	.022	.021	.023	.022	.025	.023	.023	.026

[a] Some of these figures appear to be one order of magnitude too high, perhaps because of misplaced decimal points.

[b] Value is misquoted in Wells.

[c] Niobium plus tantalum.

[d] Yttrium plus cerium plus all other rare earths.

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