

# Periodic Table for Mantle Geochemistry

| Periodic Table for Mantle Geochemistry                                                                           |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              | inert                    |                   |
|------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|-----------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|----------------------------|------------------------------|--------------------------|-------------------|
| 1<br>H<br>hydrogen                                                                                               |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              | 2<br>He<br>helium        |                   |
| 2 +                                                                                                              |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              | 3He<br>Th                |                   |
| 3 0.77<br>Li<br>lithium                                                                                          | 4 0.44<br>Be<br>beryllium  |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          | 10<br>Ne<br>neon  |
| 11 0.98<br>Na<br>sodium                                                                                          | 12 0.72<br>Mg<br>magnesium |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          | 18<br>Ar<br>argon |
| 0.15%                                                                                                            | 20.4%                      |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          | 36Ar<br>K         |
| Element compatibility during pressure-release melting                                                            |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
| 3 +                                                                                                              |                            | 4 +                        |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
| <div><div>concentrated in crust, OIB</div><div>concentrated in MORB</div><div>concentrated in mantle</div></div> |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
| 19 1.37<br>K<br>potassium                                                                                        | 20 1.06<br>Ca<br>calcium   | 21 0.75<br>Sc<br>scandium  | 22 0.62<br>Ti<br>titanium  | 23 0.62<br>V<br>vanadium      | 24 0.6<br>Cr<br>chromium   | 25 0.82<br>Mn<br>manganese | 26 2+, .71<br>Fe<br>iron   | 27 0.75<br>Co<br>cobalt       | 28 0.67<br>Ni<br>nickel     | 29 0.75<br>Cu<br>copper  | 30 0.95<br>Zn<br>zinc       | 31 0.6<br>Ga<br>gallium  | 32<br>Ge<br>germanium    | 33<br>As<br>arsenic      | 34<br>Se<br>selenium       | 35 1.96<br>Br<br>bromine     | 36<br>Kr<br>krypton      |                   |
| 40K-0.1140Ar<br>0.8940Ca<br>(1.256)                                                                              | 0.94%<br>K                 |                            | 0.063%<br>K                | 4+                            | 5+                         | 0.11%                      | 0.029%                     | 2.4%                          | 0.055%                      |                          |                             |                          |                          | ⊗                        |                            | ⊗                            | ⊗                        |                   |
| 37 1.53<br>Rb<br>rubidium                                                                                        | 38 1.17<br>Sr<br>strontium | 39 0.90<br>Y<br>yttrium    | 40 0.72<br>Zr<br>zirconium | 41 0.64<br>Nb<br>niobium      | 42<br>Mo<br>molybdenum     | 43<br>Tc<br>technetium     | 44 0.62<br>Ru<br>ruthenium | 45 0.66<br>Rh<br>rhodium      | 46 0.76<br>Pd<br>palladium  | 47<br>Ag<br>silver       | 48<br>Cd<br>cadmium         | 49<br>In<br>indium       | 50<br>Sn<br>tin          | 51<br>Sb<br>antimony     | 52<br>Te<br>tellurium      | 53 2.2<br>I<br>iodine        | 54<br>Xe<br>xenon        |                   |
| 87Rb-87Sr<br>(48.8G)                                                                                             | 86Sr<br>Rb                 |                            |                            | 5+                            |                            |                            | 4+                         | 3+                            | 3+                          |                          |                             |                          |                          |                          |                            | ⊗<br>129I-<br>129Xe<br>(16M) | ⊗<br>130Xe<br>I, U<br>Pu |                   |
| 55 1.75<br>Cs<br>cesium                                                                                          | 56 1.35<br>Ba<br>barium    | 57 1.16<br>La<br>lanthanum | 72 0.76<br>Hf<br>hafnium   | 73 0.64<br>Ta<br>tantalum     | 74<br>W<br>tungsten        | 75<br>Re<br>rhenium        | 76 0.63<br>Os<br>osmium    | 77 0.68<br>Ir<br>iridium      | 78 0.63<br>Pt<br>platinum   | 79 0.67<br>Au<br>gold    | 80<br>Hg<br>mercury         | 81<br>Tl<br>thallium     | 82 2+, 1.2<br>Pb<br>lead | 83<br>Bi<br>bismuth      | 84<br>Po<br>polonium       | 85<br>At<br>astatine         | 86<br>Rn<br>radon        |                   |
|                                                                                                                  |                            |                            | 177Hf<br>Lu                |                               | ●                          | 187Re-187Os<br>(42G)       | 188Os<br>Pt                | ●                             | ●<br>(880G)                 |                          |                             |                          | ●<br>204Pb<br>Th         |                          |                            | ⊗                            |                          |                   |
| 87<br>Fr<br>francium                                                                                             | 88<br>Ra<br>radium         | 88<br>Ac<br>actinium       |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
| 226Ra (1.6K)<br>228Ra (5.8K)                                                                                     | Th                         |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
| 3 +                                                                                                              |                            |                            | 58 1.14<br>Ce<br>cerium    | 59 1.13<br>Pr<br>praseodymium | 60 1.11<br>Nd<br>neodymium | 61<br>Pm<br>promethium     | 62 1.08<br>Sm<br>samarium  | 63 2+, 1.25<br>Eu<br>europium | 64 1.05<br>Gd<br>gadolinium | 65 1.04<br>Tb<br>terbium | 66 1.03<br>Dy<br>dysprosium | 67 1.02<br>Ho<br>holmium | 68 1.0<br>Er<br>erbium   | 69 0.99<br>Tm<br>thulium | 70 0.99<br>Yb<br>ytterbium | 71 0.98<br>Lu<br>lutetium    |                          |                   |
|                                                                                                                  |                            |                            | 144Nd<br>Sm                |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            | 176Lu-<br>176Hf (35G)        |                          |                   |
|                                                                                                                  |                            |                            |                            |                               |                            |                            |                            |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |
|                                                                                                                  |                            |                            | 90<br>Th<br>thorium        | 91<br>Pa<br>protactinium      | 92<br>U<br>uranium         | 93<br>Np<br>neptunium      | 94<br>Pu<br>plutonium      |                               |                             |                          |                             |                          |                          |                          |                            |                              |                          |                   |

● concentrated in core  
⊗ concentrated in exosphere

isotope decay half-life:

y = years

K =  $10^3$  years

M =  $10^6$  years

G =  $10^9$  years

|                        |                                                                                            |               |    |
|------------------------|--------------------------------------------------------------------------------------------|---------------|----|
| atomic #               | 90                                                                                         | 1.05          | 4+ |
|                        | Th                                                                                         |               |    |
|                        | thorium                                                                                    |               |    |
| isotope decay sequence | $^{232}\text{Th} \rightarrow \dots \rightarrow ^{208}\text{Pb}, 6^4\text{He} (14\text{G})$ | ← daughter(s) |    |
|                        | $^{230}\text{Th} (75\text{K})$                                                             | ← parent(s)   | U  |

|                                                                                            |            |                                |                                                                                                                                                                                                                                                                   |                       |                                                                                                                                 |
|--------------------------------------------------------------------------------------------|------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 90<br>Th<br>thorium                                                                        | 1.05<br>4+ | 91<br>Pa<br>protactinium       | 92<br>U<br>uranium                                                                                                                                                                                                                                                | 93<br>Np<br>neptunium | 94<br>Pu<br>plutonium                                                                                                           |
| $^{232}\text{Th} \rightarrow \dots \rightarrow ^{208}\text{Pb}, 6^4\text{He} (14\text{G})$ |            | $^{231}\text{Pa} (34\text{K})$ | $^{235}\text{U} \rightarrow \dots \rightarrow ^{207}\text{Pb}, 4^4\text{He} (0.7\text{G})$<br>$^{238}\text{U} \rightarrow \dots \rightarrow ^{206}\text{Pb}, 8^4\text{He}, ^{131}\text{Xe}$<br>$^{132}\text{Xe}, ^{134}\text{Xe}, ^{136}\text{Xe} (4.55\text{G})$ |                       | $^{244}\text{Pu} \rightarrow \dots \rightarrow ^{131}\text{Xe}, ^{132}\text{Xe}, ^{134}\text{Xe}, ^{136}\text{Xe} (82\text{M})$ |

Actinide Series

## MAJOR ELEMENT COMPOSITION

1 Mantle:  $\text{Na}_{0.02} \text{Ca}_{0.08} \text{Al}_{0.10} \text{Fe}_{0.14} \text{Mg}_{1.2} \text{SiO}_{3.6}$   
(in table, mantle major element abundances are given in atom-%)

2 MORB:  $\text{Na}_{0.08} \text{Ca}_{0.28} \text{Al}_{0.39} \text{Fe}_{0.13} \text{Mg}_{0.3} \text{SiO}_{3.4}$

3 Crust:  $\text{Na}_{0.10} \text{Ca}_{0.12} \text{Al}_{0.32} \text{Fe}_{0.09} \text{Mg}_{0.11} \text{SiO}_{2.9}$

1. LOSIMAG compositional model----Hart and Zindler, Chem. Geol., 57, 247-267, 1986

2. Promotive MORB composition-----Green et al., 1979

3. Rudnick and Fountain, Nature and composition of the continental crust---A lower crustal perspective, Rev. GEophys., 33, 267-309, 1979

Abbreviations

crust = continental crust

MORB = mid-ocean ridge basalt

OIB = ocean-island basalt