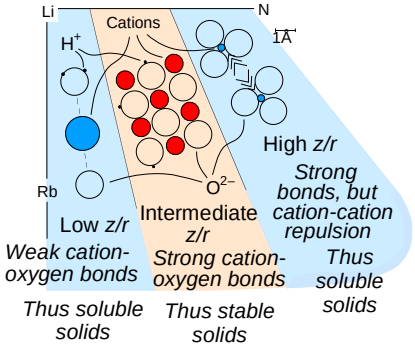
A bit of the *Earth Scientist's Periodic Table of the Elements and Their Ions* as a cross-section of the Earth:

Conceptual model of the behavior of oxides of hard (and intermediate) cations



Contoured values of ionic potential (charge ÷ radius):

36
12
4
2

"Hard" or "Type A" Cations
(All electrons removed from outer shell)
(Thus a noble-gas-like configuration of the outer shell)

H^+ 1 Hydrogen ion *m*=1.0079 *r*=10^{-5} **1** 2 *3*						
Li^+ 3 Lithium ion *m*=6.941 *r*=0.60 6 **7**	Be^{2+} 4 Beryllium ion *m*=9.012 *r*=0.31 **9**	B^{3+} 5 Boron as borate ($B(OH)_3$ or $B(OH)_4^-$) *m*=10.811 *r*=0.20 10 **11**	C^{4+} 6 Carbon, as CO_2, bicarbonate (HCO_3^-) & carbonate (CO_3^{2-}) *m*=12.011 *r*=015 **12** 13 *14*	N^{5+} 7 Nitrogen as nitrate (NO_3^-) *m*=14.007 *r*=0.11 **14** 15		
Na^+ 11 Sodium ion *m*=22.990 *r*=0.95 **23**	Mg^{2+} 12 Magnesium ion *m*=24.305 *r*=0.65 **24** 25 26	Al^{3+} 13 Aluminum ion as Al^{3+} or $Al(OH)_n^{3-n}$ *m*=26.982 *r*=0.50 **27**	Si^{4+} 14 as silicate (SiO_4^{4-}) or $Si(OH)_4^0$ *m*=28.086 *r*=0.41 **28** 29 30	P^{5+} 15 Phosphorus as phosphate (PO_4^{3-} and HPO_4^{2-}) *m*=30.974 *r*=0.34 **31**	S^{6+} 16 Sulfur as sulfate (SO_4^{2-}) *m*=32.066 *r*=0.29 **32** 33 34 36	Cl^{7+} as perchlorate (ClO_4^-) *r*=0.27
K^+ 19 Potassium ion *m*=39.098 *r*=1.33 **39** *40* 41	Ca^{2+} 20 Calcium ion *m*=40.078 *r*=0.99 **40** 42 43 44 46 48	Sc^{3+} 21 Scandium ion *m*=44.956 *r*=0.81 **45** *(48)*	Ti^{4+} 22 Titanic titanium *m*=47.867 *r*=0.68 46 47 **48** 49 50	V^{5+} 23 Vanadium ion e.g., as vanadate *m*=50.942 *r*=0.59 *50* **51**	Cr^{6+} 24 Chromium, e.g. as chromate (CrO_4^{2-}) *m*=51.996 *r*=0.52 50 **52** 53 54	

Where Fe^{2+} and Fe^{3+} would fall if they were hard cations

For the entire *Earth Scientist's Periodic Table of the Elements and Their Ions*, go to www.gly.uga.edu/railsback/PT.html

Earth:

Mantle of Mg silicate

Crust of Mg-silicate & Al-silicates (largely feldspars)

Sediments rich in silicates, carbonates, sulfates, & borates

Ocean rich in H (as H_2O) and within which nitrate cycles (but from which it rarely leaves).

Cations that enter into sedimentary carbonates, sulfates, silicates, phosphates, & borates (e.g., gypsum, calcite, dolomite, illite, smectite, apatite, and borax).

Note the presence of O^{2-} throughout

Ions that tend to enter into and/or stay in O^{2-}-bearing solids

- Ions least depleted from mantle in formation of crust
- Ions enriched in CAIs (Ca-Al-rich inclusions in meteorites) relative to the composition of the solar system
- Ions that enter early-forming phases in igneous rocks
- Ions commonly concentrated in residual soils and residual sediments. Small symbol ((S)) indicates less certainty.
- Ions concentrated in deep-sea ferromanganese nodules relative to seawater

Ions that tend to only enter O^{2-}-bearing solids late, or not at all, and instead tend to enter or remain in aqueous solution.

- Ions that enter later phases in igneous rocks because of their large size (mostly "large-ion lithophiles")
- 8 most abundant solutes dissolved in seawater
  - 9th to 16th most abundant
  - 17th to 22nd most abundant
- Most abundant solute in average river water (HCO_3^-)
  - 2nd to 8th most abundant solutes in average river water

- Cations that form simple oxide minerals
- Solutes that can be limiting nutrients in the growth of bacteria
- Solutes that can be limiting nutrients in the oceans
- Macronutrient solutes on land
- Micronutrient solutes on land
- Ions essential to the nutrition of at least some vertebrates ("essential minerals")