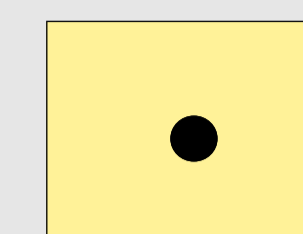


Part of An Earth Scientist's Periodic Table of the Elements and Their Ions

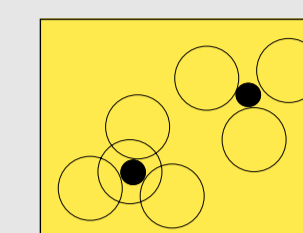
© 2003 L. Bruce Railsback, Department of Geology, University of Georgia, Athens, Georgia, 30602-2501 U.S.A. (rlsbk@gly.uga.edu). For updates and more information, see <http://www.gly.uga.edu/railsback/PT.html>.

Color of oxygen-bearing inorganic solids (e.g., minerals)

H⁺ 1 Hydrogen ion ●	Hard Cations (Cations with no outer-shell electrons)				
Li 3 Lithium ion ●	Be²⁺ 4 Beryllium ion ●	B³⁺ 5 Boron as borate (B(OH) ₃) ●	C⁴⁺ 6 Carbon, as carbonate (CO ₃ ²⁻) ●	N⁵⁺ 7 Nitrogen as nitrate (NO ₃) ●	
Na⁺ 11 Sodium ion ●	Mg²⁺ 12 Magnesium ion ●	Al³⁺ 13 Aluminum ion as Al ³⁺ or Al(OH) ₃ ●	Si⁴⁺ 14 as silicate (SiO ₄ ⁴⁻) ●	P⁵⁺ 15 Phosphorus as phosphate (PO ₄ ³⁻ and HPO ₄ ²⁻) ●	S⁶⁺ 16 Sulfur as sulfate (SO ₄ ²⁻) ●
K⁺ 19 Potassium ion ●	Ca²⁺ 20 Calcium ion ●	Sc³⁺ 21 Scandium ion ●	Ti⁴⁺ 22 Titanic titanium ●	V⁵⁺ 23 Vanadium ion e.g., as vanadate ●	Cr⁶⁺ 24 Chromium, e.g. as chromate (CrO ₄ ²⁻) ●
Rb⁺ 37 Rubidium ion ●	Sr²⁺ 38 Strontium ion ●	Y³⁺ 39 Yttrium ion ●	Zr⁴⁺ 40 Zirconium ion ●	Nb⁵⁺ 41 Niobium (or Columbian) ion ●	Mo⁶⁺ 42 Molybdenum e.g., as molybdate ●
Cs⁺ 55 Cesium ion ●	Ba²⁺ 56 Barium ion ●	La³⁺ & REEs 57-71	Hf⁴⁺ 72 Hafnium ion ●	Ta⁵⁺ 73 Tantalum ion e.g., as tantalate ●	W⁶⁺ 74 Tungsten (Wolfram) e.g., as tungstate ●
Fr⁺ 87 Francium ion ●	Ra²⁺ 88 Radium ion ●	Ac³⁺ 89 Actinium ion ●	Th⁴⁺ 90 Thorium ion ●	Pa⁵⁺ 91 Protactinium ion ●	U⁶⁺ 92 Uranium, e.g. as uranyl (UO ₂ ²⁺) ●



Typical colors of carbonates, nitrates, phosphates, silicates, arsenates, tungstates, oxides etc. of the cation indicated



Typical colors of sodium-, magnesium-, potassium, and calcium-bearing oxysalts of the cation indicated

Caveats:

- 1) Colors of specific samples of minerals are commonly controlled by minor or trace elements, or are caused by vacancies of defects.
- 2) The colors shown here are generalizations among the mineral groups listed above (i.e., a generalization of the color of the carbonate, nitrate, phosphate, etc. of a cation)
3. "White" and "colorless" are both shown as white on this table.

Intermediate Cations (Cations with some remaining outer-shell electrons)

Ti³⁺ 22 Titanium ion ●	V⁴⁺ 23 Vanadium ion ●	Cr³⁺ 24 Chromic chromium ●	Mn^{3,4+} 25 Manganese ion ●	Fe³⁺ 26 Ferric iron ●	Co³⁺ 27 Cobaltic cobalt ●	Ni³⁺ 28 Nickel ion ●	Cu²⁺ 29 Cupric copper ●	S⁴⁺ 16 Sulfur as sulfite (SO ₃ ²⁻) ●	As⁵⁺ 33 arsenate (AsO ₄ ³⁻) ●	Se⁶⁺ 34 as selenate (SeO ₄ ²⁻) ●
Ti²⁺ 22 Titanium ion ●	V³⁺ 23 Vanadous vanadium ●	Cr²⁺ 24 Chromous chromium ●	Mn²⁺ 25 Manganous Mn ●	Fe²⁺ 26 Ferrous iron ●	Co²⁺ 27 Cobaltous cobalt ●	Ni²⁺ 28 Nickel ion ●	Cu⁺ 29 Cuprous copper ●	Zn²⁺ 30 Zinc ion ●	Ga³⁺ 31 Gallium ion ●	Ge⁴⁺ 32 Germanium ion ●
Mo⁴⁺ 42 Molybdenum ion ●	Ru^{3,4+} 44 Ruthenium ion ●	Rh²⁺ 45 Rhodium ion ●	Pd²⁺ 46 Palladium ion ●	Ag⁺ 47 Silver ion ●	Cd²⁺ 48 Cadmium ion ●	In^{1,3+} 49 Indium ion ●	Sn²⁺ 50 Stannous tin ●	Sb³⁺ 51 Antimony ion, as in antimonites ●	Te⁴⁺ 52 Tellurium ion, as in tellurites ●	I⁵⁺ 53 Iodine as iodate (IO ₃) ●
W⁴⁺ 74 Tungsten (Wolfram) ion ●	Re⁴⁺ 75 Rhenium ion ●	Os⁴⁺ 76 Osmium ion ●	Ir⁴⁺ 77 Iridium ion ●	Pt²⁺ 78 Platinum ion ●	Au⁺ 79 Gold ion ●	Hg⁺ 80 Mercurous ion ●	Tl⁺ 81 Thallic thallium ●	Pb²⁺ 82 Plumbous lead ●	Bi³⁺ 83 Bismuth ion ●	Po 84 Polonium ●
U⁴⁺ 92 Uranium ion ●						Hg²⁺ 80 Mercuric ion ●	Tl³⁺ 81 Thallic thallium ●	Pb⁴⁺ 82 Plumbic lead ●	Bi⁵⁺ 83 Bismuth ion ●	

Rare earth elements (REEs)													
La³⁺ 57 Lanthanum ion ●	Ce⁴⁺ 58 Cerium ion ●	Pr³⁺ 59 Praseodymium ion ●	Nd³⁺ 60 Neodymium ion ●	Sm³⁺ 62 Samarium ion ●	Eu³⁺ 63 Europium ion ●	Gd³⁺ 64 Gadolinium ion ●	Tb³⁺ 65 Terbium ion ●	Dy³⁺ 66 Dysprosium ion ●	Ho³⁺ 67 Holmium ion ●	Er³⁺ 68 Erbium ion ●	Tm³⁺ 69 Thulium ion ●	Yb³⁺ 70 Ytterbium ion ●	Lu³⁺ 71 Lutetium ion ●
Lanthanides:													

Main observations:

1. Most minerals with color contain intermediate cations.
2. Minerals of hard cations typically have no color, unless impurities or defects give them color.
3. Exceptions to Observation 2 occur in hard cations of high (e.g. 6+) charge, probably because these cations have not truly lost all their outer shell electrons.