

A table of systematic mineralogy II: redox implications

Minerals consisting of uncharged atoms (i.e., in elemental state)	Minerals consisting of cations bonded to single anions (no radical groups or complex ions)	Minerals consisting of cations bonded to negatively-charged radical groups (i.e., to complex ions like CO_3^{2-} or AsS_3^{2-})			
<p>Native elements</p> <p>Sulfur (S) Diamond (C) Copper (Cu)</p> <p>Formation of these minerals typically requires intermediate or reducing redox conditions, because all elements that form native minerals also have charged valence states, commonly oxidized states, that they might otherwise take.</p>	<p>Fluorides Fluorite (CaF_2)</p> <p>Halides ("Group VII -ides") (and thus minerals with 1- anions)</p> <p>Chlorides Halite ($NaCl$)</p> <p>Bromides Bromargyrite ($AgBr$)</p> <p>Iodides Iodargyrite (AgI)</p>	<p>Fluosalts:</p>	<p>Fluoborates Fluosilicates</p> <p>Ferruccite ($NaBF_4$) Hieratite (K_2SiF_6)</p> <p>Formation of the halide minerals is indifferent to redox conditions, because the Group VII elements involved have one, or essentially only one, valence state (-1). ("Essentially only one" is required because iodine <i>can</i> also form iodate minerals).</p>	<p>Negative charge in mineral comes from halide anions</p>	
	<p>Oxides Hematite (Fe_2O_3)</p> <p>Formation of these minerals requires at least somewhat oxidizing conditions, because elements involved (e.g., C, N, P, S) have more reduced valence states as alternatives. These minerals thus commonly form in near-Earth-surface environments.</p>	<p>Oxysalts:</p>	<p>Silicates Borates Carbonates Nitrates Phosphates Sulfates</p> <p>Vanadates Chromates Niobates Molybdates Tantalates Tungstates</p> <p>Arsenates Selenates Antimonates Tellurates Iodates</p> <p>Calcite ($CaCO_3$)</p>	<p>Sulfites Arsenites Selenites Antimonites Tellurites</p>	<p>Negative charge in mineral comes from anions of Group VI elements</p>
	<p>"Group VI -ides" (and thus minerals with 2- anions)</p> <p>Sulfides Galena (PbS)</p> <p>Selenides Achavalite ($FeSe$)</p> <p>Tellurides Altaite ($PbTe$)</p>	<p>Sulfosalts:</p>	<p>Sulfarsenates Sulfogermanates Sulfantimonates Sulfostannates</p> <p>Sulfovanadates Sulfarsenites Sulfantimonites Sulfobismuthites</p> <p>Selenioantimonates Seleniobismuthites</p> <p>Telluribismuthites</p>	<p>Intermediate redox states</p> <p>Pyrrargyrite (Ag_3SbS_3) Permingeatite (Cu_3SbSe_4) Volynskite ($AgBiTe_2$)</p>	<p>Negative charge in mineral comes from anions of Group VI elements</p>
	<p>"Group V -ides" (and thus minerals with 3- anions)</p> <p>Nitrides Osbornite (TiN)</p> <p>Phosphides Barringerite (Fe,Ni)₂P</p> <p>Arsenides Löllingite ($FeAs_2$)</p> <p>Antimonides & Bismuthides Sobolevskite ($PdBi$)</p>		<p>Formation of these minerals requires reducing conditions, because elements involved (e.g., C, N, P, S, As, Se, Sb) have more oxidized valence states as alternatives. For example, most nitride, phosphide, carbide, silicide, etc. minerals are known largely or only from meteorites, cosmic dust, or deep-earth samples. Likewise, many sulfides and sulfosalts are known from ore deposits that formed at depth rather than at the Earth's surface.</p>		<p>Negative charge in mineral comes from anions of Group IV and V elements</p>
<p>"Group IV -ides" (and thus minerals with 4- anions)</p> <p>Carbides Moissanite (SiC)</p> <p>Silicides Gupelite (Fe_3Si)</p>					

The characterizations above are only generalizations about entire classes of minerals. For example, siderite ($Fe^{2+}CO_3$) requires somewhat reducing conditions to form, whereas molysite ($Fe^{3+}Cl_3$) would likely form in oxidizing conditions.