

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⁻)	Negative charge in mineral comes from anions of Group VI elements
<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 (CaF₂)</p> <p>Chlorides Halite (NaCl)</p> <p>Bromides Bromargyrite (AgBr)</p> <p>Iodides Iodargyrite (AgI)</p>	<p>Fluosalts: Fluoborates Fluosilicates</p> <p>Ferruccite (NaBF₄) Hieratite (K₂SiF₆)</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 can also form iodate minerals).</p>	<p>Negative charge in mineral comes from halide anions</p>
<p>Native elements</p>	<p>Oxides Hematite (Fe₂O₃)</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</p> <p>Carbonates Niobates</p> <p>Nitrates Molybdates</p> <p>Phosphates Tantalates</p> <p>Sulfates Tungstates Calcite (CaCO₃)</p> <p>Vanadates Chromates</p> <p>Arsenates Selenates</p> <p>Antimonates Tellurates</p> <p>Iodates Calcite (CaCO₃)</p>	<p>Sulfites Arsenites</p> <p>Selenites Antimonites</p> <p>Tellurites</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>Sulfides Galena (PbS)</p> <p>Selenides Achavalite (FeSe)</p> <p>Tellurides Altaite (PbTe)</p>	<p>Sulfosalts:</p> <p>Sulfarsenates Sulfovanadates Sulfogermanates Sulfantimonates Sulfostannates</p> <p>Selenioantimonates Seleniobismuthites</p> <p>Sulfosalts:</p> <p>Sulfarsenites Sulfantimonites Sulfobismuthites</p> <p>Pyrrargyrite (Ag₃SbS₃)</p>	<p>Negative charge in mineral comes from anions of Group VI 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>Nitrides Osbornite (TiN)</p> <p>Phosphides Barringerite (Fe,Ni)₂P</p> <p>Arsenides Löllingite (FeAs₂)</p> <p>Antimonides & Bismuthides Sobolevskite (PdBi)</p> <p>Carbides Moissanite (SiC)</p> <p>Silicides Guepuite(Fe₃Si)</p>	<p>Seleniosalts:</p> <p>Seleniobismuthites</p> <p>Telluriosalts:</p> <p>Telluribismuthites</p> <p>Volynskite (AgBiTe₂)</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>

The characterizations above are only generalizations about entire classes of minerals. For example, siderite (Fe²⁺CO₃) requires somewhat reducing conditions to form, whereas molybdate (Fe³⁺Cl₃) would likely form in oxidizing conditions.