

GY302 Lab 7

Native Elements

Native Elements

- Metals
 - Gold Group
 - Gold, Au; Silver, Ag; Copper, Cu
 - Platinum Group
 - Platinum, Pt; Palladium, Pd; Platiniridium, (Pt,Ir)
 - Iron Group
 - Iron, Fe; Nickel-iron, (Ni,Fe)
- Semi-metals and Nonmetals
 - Arsenic Group
 - Arsenic, As; Antimony, Sb; Bismuth, Bi; Vanadium, V
 - Sulfur Group
 - Sulfur, S
 - Carbon Group
 - Diamond, C; Graphite, C

Gold Group

- Au, Ag, Cu, Pb
- Cubic (isometric) $Fm\bar{3}m$
- 12-coordination- each atom is surrounded by 12 neighboring atoms.
- Crystals are rare.

Gold (Au)

- Habit: cubic
- Cleavage: none; hackly fracture
- Hardness: 2.5-3.0
- Tenacity: very malleable, ductile, and sectile.
- S.G. : 19.3, less with contents of Ag, Cu, and other substitutions.
- Color and streak: Gold-yellow when pure, whiter with Ag, orange-red with Cu.
- Luster and light transmission: Metallic, Opaque.
- Chemistry: most native gold contains 10-15% Ag.
- Diagnostic: color, malleability, sectility, conductivity.
- Occurrence and Associations: hydrothermal veins and placers. Gold in veins is associated with pyrite, chalcopyrite, and sphalerite. Placer gold is associated with other heavy minerals (magnetite, zircon, rutile, etc.).

Silver (Ag)

- Habit: crystals rare, cubic.
- Twinning: common.
- Cleavage and fracture: None. Hackly.
- Hardness: 2.5-3.0
- Tenacity: sectile, ductile, and malleable.
- S.G. : 10.1-11.1, differing with dissolved Au, Cu, etc.
- Color: Silver-white, commonly gray to black when tarnished.
- Luster and light transmission: Metallic. Opaque.
- Chemistry: Native Ag may contain Au, As, Hg, Sb.
- Diagnostic: Color, tarnish, sectility, and hackly fracture. Soluble in nitric acid.
- Occurrence and associations: Ag occurs in small portions of oxidized zones in ore deposits, and as deposits from hydrothermal fluids in veins. Ag occurs with sulfides, zeolites, calcite, barite, fluorite, and quartz. Much Ag production is a by-product of Au refining.

Copper (Cu)

- Habit: crystals are rare, cubic or dodecahedral.
- Twinning: common on {111}.
- Cleavage & Fracture: none, hackly.
- Hardness: 2.5-3.0.
- Tenacity: Ductile and malleable.
- Color: light rose on fresh surface.
- Luster and light transmission: Metallic. Opaque.
- Chemistry: Native Cu contains trace quantities of Ag, As, Fe, Bi, Sb.
- Diagnostic: Color, malleability, sectile, hackly fracture. Cu dissolves in nitric acid.
- Occurrence and Associations: basic extrusive igneous rocks associated with chalcocite, bornite, epidote, calcite, chlorite, zeolites.

Platinum Group: Platinum (Pt)

- Habit: Crystals rare, typical as grains, scales, nuggets.
- Cleavage & Fracture: None. Hackly.
- Hardness: 4-4.5, increasing with Fe content.
- Tenacity: Malleable and ductile.
- S.G. : 14-19 (21.46 for pure Pt)
- Color and streak: Whitish steel-gray to dark gray.
- Luster and light transmission: Metallic. Opaque.
- Chemistry: Native Pt contains Fe up to 28%. Also contains Pd, Rd, Ir, Cu. Fe varieties are magnetic.
- Diagnostic: Gray color, high S.G., does not tarnish like silver, can be dissolved only in aqua regia.
- Occurrence and associations: Pt occurs in mafic and ultramafic rocks associated with olivine, pyroxene, chromite, and magnetite in “reefs” from fractional crystallization. Placer deposits are important in the Urals.

Iron Group: Iron (Fe)

- Two minerals: Fe and Fe-Ni.
- Cubic
- Ni can be 7-24%
- Extremely rare as terrestrial rocks but are typical for metallic meteorites. Also make up the core of the Earth.
- Magnetic, distinguished from magnetite by lower hardness and malleability.

Arsenic Group

- As, Sb, Bi, V
- Semi-metals
- Hexagonal
- 6-coordination

Arsenic

- Habit: Hexagonal but crystals are rare, commonly massive.
- Cleavage: {0001} perfect.
- Hardness: 3.5
- S.G. : 5.7
- Color: tin-white tarnished to gray-black.
- Streak: Tin-white to gray.
- Chemistry: most As contains some Sb. Minor amounts of Fe, Ni, Ag, or S may also substitute.
- Diagnostic: Habit and hardness. Upon heating As will give off a “garlic” odor.
- Occurrence and Associations: Hydrothermal veins with Ag, Co, or Ni ores. It is also associated with Orpiment and Realgar sulfides (orange and yellow Hg ore), Galena, Barite, Stibnite.

Antimony

- Habit: Crystals rare; typically massive; lamellar and distinctly cleavable.
- Cleavage: perfect {0001}.
- Hardness: 3-3.5
- S.G. : 6.7
- Color/Streak: Tin-white; Gray
- Chemistry: relatively pure
- Diagnostic: Melts readily at 630 C.
- Occurrence and Associations: hydrothermal veins with Ag ores and Stibnite. Less commonly with ZnS, FeS₂, PbS, and SiO₂.

Bismuth

- Habit: Crystals rare; foliated, granula.
- Color: Silver-white with reddish hues and characteristic iridescent tarnish.
- Cleavage: {0001} perfect
- Hardness: 2-2.5
- S.G. : 9.7-9.8
- Streak: Silver-white
- Diagnostic: Color, hardness, and S.G. Melts readily at 270 C.
- Occurrence and Associations: Hydrothermal veins with Co, Ni, Ag, and Sn minerals and in pegmatites.

Vanadium

- Habit: crystals rare; commonly massive
- Color: pale yellow with some iridescent tarnish, similar to Chalcopyrite.

Hardness: 5-5.5

- Cleavage: {0001} perfect
- S.G. : 5.5
- Diagnostic: Color and hardness.
- Occurrence and Associations: hydrothermal veins associated with other base metal ores of Pb, Hg, Ni, Co.

Sulfur Group

- S in three polymorphs (alpha, beta, gamma)
- Habit: orthorhombic (alpha) or monoclinic (beta, gamma).

Sulfur

- Habit: Crystals common, typically dipyramidal, also massive; $2/m2/m2/m$.
- Cleavage and fracture: {001} indistinct; conchoidal.
- Hardness: 1.5 – 2.5
- Tenacity: brittle to slightly sectile.
- S.G. : 2.07
- Color/Streak: Yellow/white
- Luster: Adamantine; resinous to greasy.
- Diagnostic: Color, low hardness, brittle, melts at 113 C, combusts at 270 C with blue flame.
- Occurrence and associations: Recent volcanic vents by sublimation; Salt domes; organic activity.

Carbon Group

- Graphite, Diamond
- Greatest contrast in physical properties between any pair of polymorphs
- Contrast in physical properties controlled by molecular structure and bonding.

Graphite

- Habit: Hexagonal $6/m\bar{2}/m\bar{2}/m$ but crystals rare; foliated masses common.
- Cleavage/Fracture: $\{0001\}$ perfect/none.
- Hardness: 1-2
- S.G. : 2.09 – 2.23
- Tenacity: flexible
- Color/Streak: black/black
- Luster: greasy; metallic to dull
- Light transmission: opaque.
- Diagnostic: Extreme softness, greasy luster, low S.G., marks paper, black color and streak.
- Occurrence and Associations: common in regional metamorphic rocks. Originates from organic carbon in protolith. Mantle derived graphite may be produced by chemical reduction of carbonatite magma.

Diamond

- Habit: $4/m\bar{3}2/m$ isometric; typically octohedral crystals
- Cleavage/Fracture: $\{111\}$ perfect/conchoidal.
- Tenacity: brittle
- Hardness: 10
- S.G. : 3.5
- Color: colorless to variable.
- Luster: Adamantine
- Light transmission: transparent to translucent.
- Diagnostic: Hardness, luster, high refractive index.
- Occurrence and Association: scattered crystals in kimberlites within diatreme pipes; also from stream gravel deposits with associated with other resistant minerals.