A few silicate minerals

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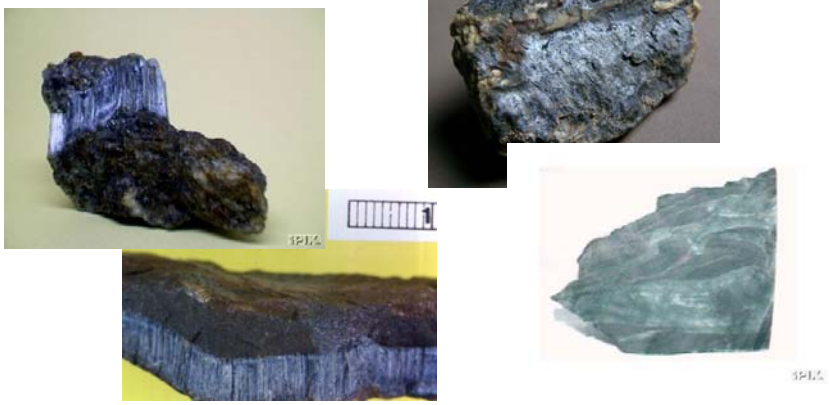
Nesosilicates / Garnets $(X_3^{2+}Y_2^{3+}[SiO_4]_3)$

Use: gemstone, abrasive

Inosilicates / Amphiboles

Bleu asbestos: Crocidolite ($Na_2(Fe,Mg)_5Si_8O_{22}(OH)_2$)



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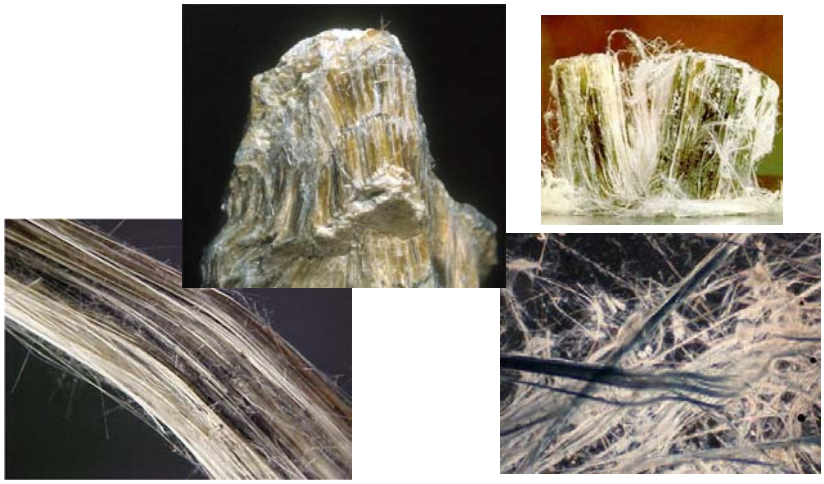
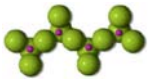
Inosilicates / Amphiboles

Brown asbestos: Amosite ($Fe_7Si_8O_{22}(OH)_2$)





Inosilicates / Amphiboles

Green asbestos. ex. : Actinolite $(Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2)$

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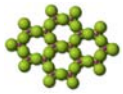
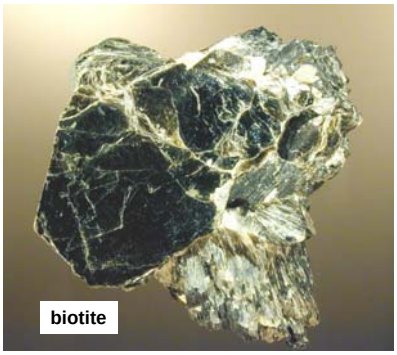


Phyllosilicates / Micas

Muscovite $(KAl_2[(OH,F)_2|AlSi_3O_{10}])$ white mica,

Biotite $(K(Mg,Fe^{2+},Mn^{2+})_3[(OH,F)_2(Al,Fe^{3+},Ti^{3+})Si_3O_{10}])$ black/brown mica

Use: Heat, acoustic and electric insulator, paints



Stony materials and conservation of the built heritage – Natural Stone _Mineralogy_ BR /23

Phyllosilicates / Clay minerals

Kaolinite ($Al_2Si_2O_5(OH)_4$)

Use: porcelain manufacture, filler in papers

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Phyllosilicates / Clay minerals

Kaolinite ($Al_2Si_2O_5(OH)_4$)

TABLE 2. Industrial uses of kaolin.

Paper coating	Cement	Food additives
Paper filling	Pencil leads	Bleaching
Extender in paint	Adhesives	Fertilizers
Ceramic raw material	Tanning leather	Plaster
Filler in rubber	Pharmaceuticals	Filter aids
Filler in plastics	Enamels	Cosmetics
Extender in ink	Pastes and glues	Crayons
Cracking catalysts	Insecticide carriers	Detergents
Fibreglass	Medicines	Roofing granules
Foundries	Sizing	Linoleum
Desiccants	Textiles	Polishing compounds

H. H. Murray, 1999. Applied clay mineralogy today and tomorrow, Clay Minerals, *V.34, p. 39-49*

Stony materials and conservation of the built heritage – Natural Stone _Mineralogy_ BR /25

Phyllosilicates / Clay minerals

Montmorillonite $((Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2.nH_2O)$

Swelling clay mineral exchanger of ions

Use: gastric plaster, cleaner of greases (Terre de Sommières), bentonite, container for the nuclear waste

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Phyllosilicates / Clay minerals

Montmorillonite $((Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2.nH_2O)$
= smectite = bentonite

TABLE 3. Industrial uses of smectites.

Drilling mud	Medical formulations	Crayons
Foundry bond clay	Polishing & cleaning agents	Cement
Pelletizing iron ores	Detergents	Desiccants
Sealants	Aerosols	Cosmetics
Animal feed bonds	Adhesives	Paint
Bleaching clay	Pharmaceuticals	Paper
Industrial oil absorbents	Food additives	Fillers
Agricultural carriers	De-inking of paper	Ceramics
Cat box absorbents	Tape-joining compounds	Catalysts
Beer and wine clarification	Emulsion stabilizer	Pencil leads

H. H. Murray, 1999. Applied clay mineralogy today and tomorrow, Clay Minerals, *V.34, p. 39-49*

Phyllosilicates / Clay minerals

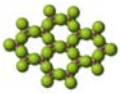
Talc ($Mg_3Si_4O_{10}(OH)_2$)

Use of talc: cosmetic, lubricant, manufacture of paper, excipient and lubricant in the pharmaceutical industry, tailor's chalk

Phyllosilicates / Chlorites

$((Mg,Fe,Mn,Al)_6((Si,Al)_4O_{10})(OH)_8)$

Use: decorative stone

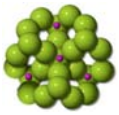


Phyllosilicates / Serpentinites

White asbestos: Chrysotile ($Mg_3Si_2O_5(OH)_4$)

Use: reinforced cement, machine parts under friction, joints for high temperature machines… because non flammable, imputrescible, flexible, resistant to the majority of chemicals and with a high breaking stress => majority of the world market of asbestos

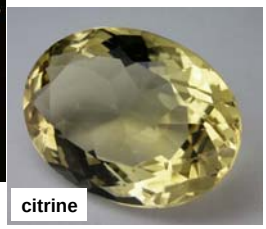
http://www.ec.gc.ca/nopp/docs/consult/Rotterdam/ca/fr/chrysotileBG.cfm



Tectosilicates / Quartz

(SiO_2)

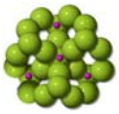
Use:
Piezoelectric (clock industry, …) and…



citrine

amethsyt

gemstones (amethyst, citrine)… cryptocristalline varieties: flint, agate, onyx, carnelian, jasper, opal



Tectosilicates / Feldspars

K- feldspars ($KAlSi_30_8$)

Use: ceramics, porcelain, glass, bricks, soaps, scouring powders, gemstones

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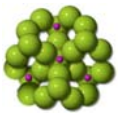
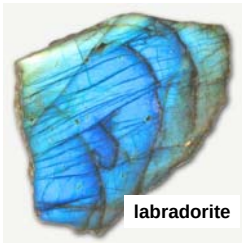


Tectosilicates / Feldspars

Plagioclases ($AlSi_30_8$)(Ca,Na)



Use: ceramics, porcelain, glass, bricks, soaps, scouring powders, gemstones

Stony materials and conservation of the built heritage – Natural Stone _Mineralogy_ BR /33

Tectosilicates / Feldspathoids

Lazurite ($(Na, Ca)_8(Al, Si)_{12}O_{24}S_2$ FeS- $CaCO_3$)

Use: gemstone, blue pigment

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A few non silicate minerals

Stony materials and conservation of the built heritage – Natural Stone _Mineralogy_ BR /35

Carbonates / **Calcite** ($CaCO_3$)

Use: white pigment (calcite as chalk used since prehistory), raw material of lime

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Carbonates / **Azurite** ($2CuCO_3,Cu(OH)_2$)

Use: blue pigment, gemstone

Carbonates / Malachite ($CuCO_3$,$Cu(OH)_3$)

Use: green pigment, gemstone

polished roller

Carbonates / Cerussite ($PbCO_3$)

Use: cosmetic (in the past since antiquity); white pigment (= white lead)

Sulfates / Gypsum ($CaSO_4,2H_2O$)

Selenite (= pierre de lune)

Sulfates / Gypsum ($CaSO_4,2H_2O$)

Use: raw material of plaster; fertilizer and soil conditioner, Tofu coagulant, blackboard chalk

Sulfates / Gypsum alabaster ($CaSO_4,2H_2O$)

Use: decorative stone

Sulfates / Gypsum ($CaSO_4,2H_2O$)

Weathering mineral: coming from the air pollution, the stone itself or from cements => degrading stones

Sulfates / Barite ($BaSO_4$)

Use: major source of barium, white pigment (blanc fixe), used in paper or paint manufacturing, radiography, heavy filler

Halides / Halite (NaCl)

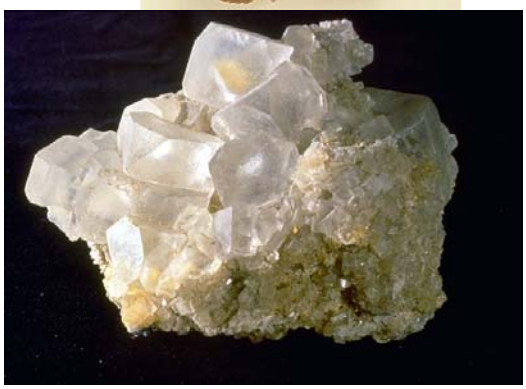
Use: table salt, road salt

Danger for building stones: crystallisation damp patches

Halides / Sylvite (KCl)

Use: fertilizer, substitute for table salt, lethal injection

Danger for building stones: crystallisation, damp patches



Halides / Fluorite (CaF_2)

Use: manufacture of hydrofluoric acid, enamels, glass fibre; used as camera lens; purple pigment; gemstone

Oxides / Hematite (Fe_2O_3)

Use: red pigment; gemstone





Oxides / Goethite (FeO(OH))

Use: yellow pigment


Oxides / Rutile (TiO_2)

Use: white pigment (artificial); manufacture of paints; +/- in gemstones

Oxides / Corundum (Al_2O_3)

Use:
abrasive;
gemstones

sapphire

ruby

Oxides / Minium (Pb_3O_4)

Use: red pigment, manufacture of glass, protecting paint against the corrosion of metals

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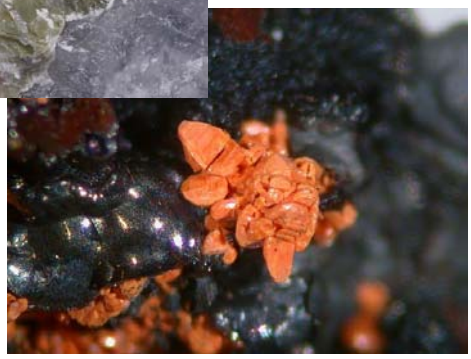
Oxides / Massicot (or litharge) (PbO)

Use: yellow pigment, manufacture of glass, of oils and varnishes (desiccant), production of insecticides



Sulfides / Galena (PbS)

Use: black pigment, cosmetic (khol), semiconductor in old wireless systems

Sulfides / Pyrite (FeS_2) (= fool's gold)

Use: production of sulfur dioxide for paper industry or manufacturing of sulfuric acid

"Dangers" in building oxidation makes it dangerous in aggregates of concrete; rost patches on stones (marble, sandstones,...)

Sulfides / Realgar (AsS)

Use: red pigment; fireworks

Problems: unstable with light (=> yellow pararealgar)

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Sulfides / Orpiment (As_2S_3)

Use: yellow pigment; production of semiconductors and photoconductors, fireworks

Problems: incompatible with pigments like lead and copper-based; it blackens in contact with the air

Sulfides / Cinnabar (HgS)

Use: red pigment; medicine, drug, food dye

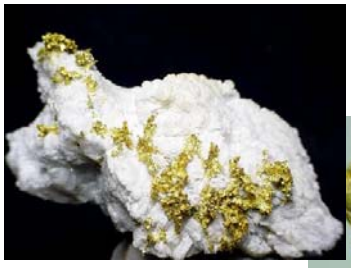
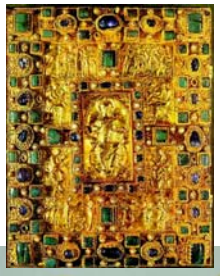
Problems: it blackens in contact with the air

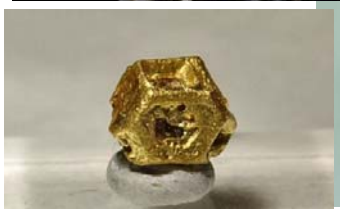
Phosphates / Apatite ($Ca_5(PO_4)_3(OH, F, Cl)$)

Use: fertilizer; gemstone; new stone consolidant

Elements / Gold (Au)

Use: noble metal, decorative metal, gilding; conductive coating, money

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Elements / Silver (Ag)

Use: noble metal; decorative metal; printed circuits; electrical contacts; dental alloys; antibacterial; money