

<b>Table 106</b>		<b>Micas</b>				
<i>Minerals</i>	<i>Formula</i>	<i>Color/Luster</i>	<i>SG</i>	<i>H</i>	<i>Crystal system/ habit</i>	<i>Occurrences</i>
<b>Biotite</b> for Jean Baptiste Biot (1774-1862), French physicist	$K(Mg, Fe)_3(Al, Fe)Si_3O_{10}(OH, F)_2$	green, black, dark brown, yellow; transparent - opaque; splendid, submetallic, vitreous	2.7 - 3.1	2½ - 3	monoclinic; short prismatic or tabular xls; massive aggregates of cleavable scales	mainly in granites, pegmatites, gabbros, norites, diorites, schists, phyllites, and gneisses
<b>Lepidolite</b> Greek <i>lepis</i> = scale and <i>lithos</i> = stone due to its micaceous structure	$K(Li, Al)_3(Si, Al)_4O_{10}(F, OH)_2$	rose-red, violet-gray, lilac, pink, purple, yellowish, grayish white, white; transparent - translucent; pearly	2.8 - 3.3	2½ - 3	monoclinic; tabular xls, thick cleavable masses, coarse to fine scaly aggregates	almost exclusively in granite pegmatites, and less commonly in granites, aplites, and high-temperature tin-bearing veins
<b>Muscovite</b> Muscovy glass, from Muscovy Province, Russia	$KAl_2(AlSi_3O_{10}(OH, F)_2$	colorless, gray, brown, pale green, violet, yellow, dark-olive green, ruby; transparent - translucent; vitreous - pearly or silky	2.77 - 2.88	2½ - 4	monoclinic; tabular xls, hexagonal or diamond-shaped in cross section; commonly lamellar or scaly massive	many geological environments, especially granites and granitic pegmatites; phyllites, schists and gneisses; in dendritic or authigenic sediments
<b>Phlogopite</b> Greek <i>phlogistos</i> = to burn or inflame alluding to its reddish tinge	$KMg_3(AlSi_3O_{10}(OH, F)_2$	yellowish brown, brown to brownish red, colorless, white, greenish; transparent to translucent; pearly	2.76 - 2.90	2 - 2½	monoclinic; prismatic xls, usually tapered, often long and coarse	in metamorphic limestones and ultrabasic rocks
<b>Roscoelite</b> Henry Enfield Roscoe (1833-1915), English chemist who first prepared pure vanadium	$K(V, Al, Mg)_2AlSi_3O_{10}(OH)_2$	clove brown to greenish brown, dark green; translucent; pearly	2.97	2½	monoclinic; minute scales	interlaminated with native gold; assoc. with telluride minerals, and with uranium-vanadium deposits
<b>Zinnwaldite</b> Zinnwald, Bohemia, named for the local tin (German Zinn) veins	$KLiFe^{+2}Al(AlSi_3O_{10}(F, OH)_2$	gray, brown, sometimes dark green; transparent; vitreous	2.9 - 3.3	2½ - 4	monoclinic; short prismatic or tabular xls; disseminated scales or scaly aggregates	mainly in greisens, high-temperature quartz veins, and in granite pegmatites.

Source: various including Roberts et al., 1990

## Consumption of ground mica in the United States (tonnes)

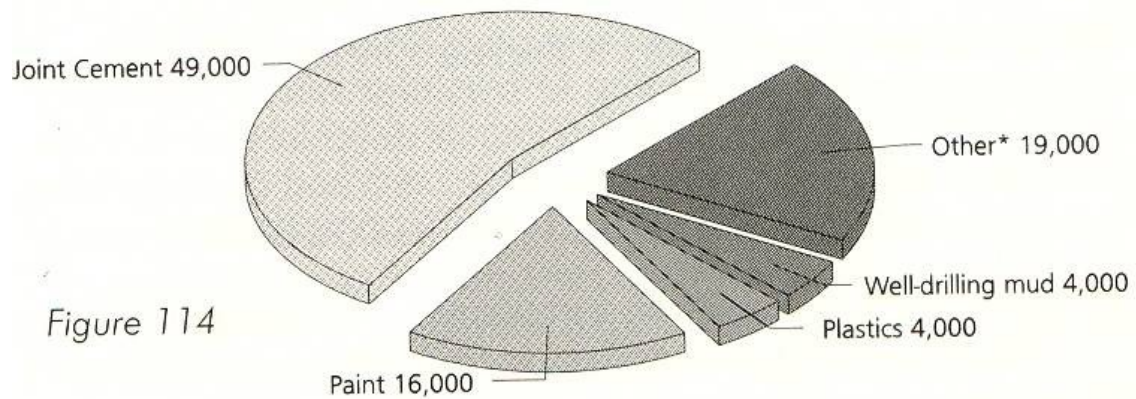


Figure 114

\* includes mica used for molded electrical insulation, rubber, textile and decorative coatings, welding rods, and miscellaneous.

Source: USBM.

<i>Minerals</i>	<i>Formula</i>	<i>Color/Luster</i>	<i>SG</i>	<i>H</i>	<i>Crystal system/ habit</i>	<i>Occurrences</i>
<b>Almandite</b> Alabanda, Asia Minor, where garnets were cut and polished	$3\text{FeO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	deep red, brownish red & black; transparent - translucent; vitreous - resinous	4.1 - 4.3	7 - 7½	cubic; dodecahedrons or trapezohedrons; massive & compact, coarse granular	schists, gneiss, other metamorphic rocks; contact zones & some igneous rocks; detrital mineral in sedimentary deposits
<b>Andradite</b> J.B.d'Andrada e Silva (1763-1838), Brazilian mineralogist	$3\text{CaO} \cdot \text{Fe}_2\text{O}_3 \cdot \text{SiO}_2$	yellowish green, greenish brown, reddish brown, grayish black, black; transparent - opaque; vitreous - resinous	3.7 - 4.1	6½ - 7	cubic; dodecahedrons or trapezohedrons; massive & compact, coarse granular	chlorite schist and serpentinite; alkaline igneous rocks (melanite); metamorphosed limestone. or contact zones
<b>Grossularite</b> Latin <i>grossularium</i> = gooseberry for its pale green color	$3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	colorless, white, gray, yellow, yellowish brown, pink, red, green, black; transparent - opaque; vitreous - resinous	3.4 - 3.6	6½ - 7	cubic; dodecahedrons or trapezohedrons; massive, compact, fine or coarse granular	metamorphosed impure calcareous rocks, especially in contact zones, assoc. with wollastonite, idocrase, diopside, scapolite, and calcite; certain schist and in serpentine
<b>Pyrope</b> Greek pyr = fire and ops = eye due to its fire-red color	$3\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	pinkish red, purplish red, orange-red, deep crimson to nearly black; transparent - translucent; vitreous	3.5 - 3.8	6½ - 7½	cubic; usually dodecahedrons or trapezohedrons, often as rounded pebbles or embedded grains	peridotites and assoc. serpentinites, and sands & gravels derived from them; eclogites, hornblende-garnet-plagioclase rocks, Precambrian anorthosites, diamond-bearing peridotites
<b>Spessartite</b> Spessart in northwestern Bavaria, Germany	$3\text{MnO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	brownish-red to red, reddish orange, yellowish brown; transparent - translucent; vitreous	3.8 - 4.3	7 - 7½	cubic; usually dodecahedrons or trapezohedrons; often striated; massive and compact, or coarse granular	granite pegmatites, gneiss, quartzite, schist, and lithophysae in rhyolite, skarn deposits
<b>Uvarovite</b> Count Sergei Semeonovich Uvarov (1786-1855), Russian nobleman, St. Petersburg	$3\text{CaO} \cdot \text{Cr}_2\text{O}_3 \cdot \text{SiO}_2$	emerald green; transparent - translucent; vitreous	3.4 - 3.8	6½ - 7	cubic; usually dodecahedrons or trapezohedrons, often striated	in assoc. with chromite is serpentine, in skarn deposits, and metamorphosed limestone

Source: various including Roberts et al. 1990

<b>Table 75</b>	<b>Grain Sizes of Commercial Garnet</b>
<b>End use</b>	<b>Size ranges (mm)</b>
Sand blasting	1.1, 0.5, 0.6/0.4, 0.4/0.2, 0.3/0.15
Water filtration	2.5/1.7, 1.1, 1.4/0.6, 0.5, 0.6/0.4, 0.4/0.2
Water jet cutting	1.0/0.3, 0.25/0.18, 0.18, 0.15, 0.18/0.85, 0.12/0.06
Coated abrasives	0.34/0.1, 0.08/0.036
Polishing/lapping	0.15/0.18, 0.10/0.15, 0.030, 0.010

Single grain size indicates mean particle size

Consumption of almandite garnet in the United States  
(tonnes)

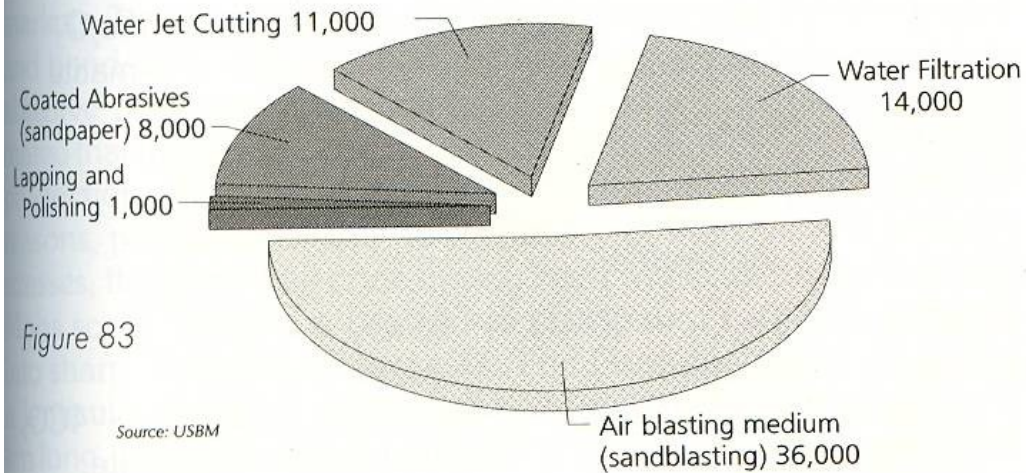


Figure 83

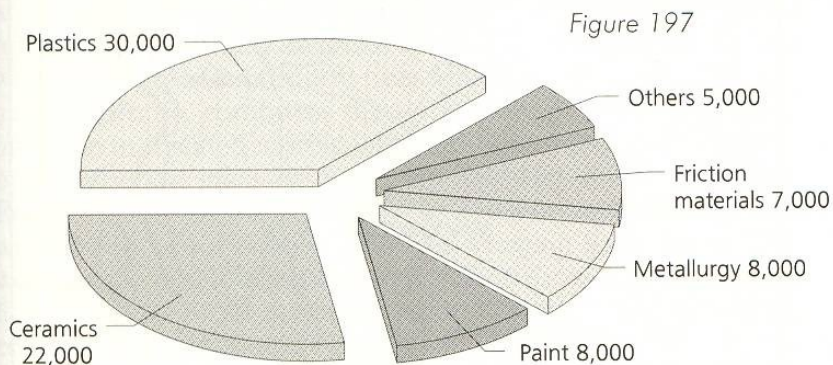
Source: USBM

Minerals and Related Minerals

Minerals	Formula	Color/Luster	SG	H	Mullitization/ vol. change	Crystal system/ habit	Occurrences
<b>Andalusite</b> locality at Andalusia, Spain	$Al_2SiO_5$ 63.2% $Al_2O_3$ 36.8% $SiO_2$	pink, reddish brown, rose red, grayish, whitish; transparent - nearly opaque; vitreous to subvitreous	3.13 3.16	$6\frac{1}{2}$ - $7\frac{1}{2}$	1,380°C  +5%	orthorhombic; prismatic xls, nearly square in x section; usually coarse; massive, compact	slates and argillaceous schists (contact); mica schist, gneiss, and related rocks (detrital); granites, granitic pegmatites
<b>Dumortierite</b> Eugène Dumortier (1802 - 1873), French paleontologist	$Al_7(BO_3)(SiO_4)_3O_3$	blue, violet, pinkish, brown; transparent - translucent; vitreous - dull	3.4	$8\frac{1}{2}$		orthorhombic; rare prismatic xls usually massive, columnar, fibrous, or granular	aluminum-rich metamorphic rocks and rarely pegmatites
<b>Kyanite (disthene)</b> Greek kyanos = dark blue reflecting its color	$Al_2SiO_5$ 63.2% $Al_2O_3$ 36.8% $SiO_2$	blue, white, gray, green, yellow, pink, or nearly black; transparent to translucent; vitreous to pearly	3.5 - 3.67	4 - $7\frac{1}{2}$	1,350°C  +18%	tridinic; long bladed xls, flattened	paragonite schists, gneiss, granite and granitic pegmatites
<b>Mullite</b> the island of Mull, Scotland	$3Al_2O_3 \cdot 2SiO_2$	colorless to pale pink; transparent to translucent; vitreous	3.03 3.6	6 - 7	-	orthorhombic; prismatic xls	in fused argillaceous inclusions in Tertiary eruptive rocks on Isle of Mull; in slags and firebricks upon heating
<b>Sillimanite</b> Professor Benjamin Silliman (1779-1864), American mineralogist, Yale	$Al_2SiO_5$ 63.2% $Al_2O_3$ 36.8% $SiO_2$	colorless, white to gray, yellowish, brownish, greenish, bluish; transparent - translucent; vitreous - silky	3.23 3.7	$6\frac{1}{2}$ - $7\frac{1}{2}$	1,550°C  +7%	orthorhombic; long prismatic xls; massive, fibrous to columnar, fine needle-shaped (hence "fibrolite" synonym)	schists, gneisses, and granites; detrital deposits
<b>Topaz</b> Greek Topazon, an island in the Red Sea, meaning to seek since it was often obscured by mist; Sanskrit topas = fire	$Al_2SiO_4(F,OH)_2$	colorless, white, gray, bluish, greenish, yellowish, yellow-brown to orange, purple, pinkish to reddish; transparent to translucent; vitreous	3.49 3.57	8		orthorhombic; short to long prismatic xls, also massive, coarse to fine granular	pegmatites and high-temperature quartz veins; cavities in granites and rhyolites; contact zones; alluvial deposits

Source: various including Roberts et al., 1990

## Wollastonite consumption in the United States



simple:



The temperature of this “wollastonite reaction” increases with pressure in a closed system, from which carbon dioxide cannot escape (at 506 MPa  $P_{\text{CO}_2}$  at a temperature of almost 800°C). However, in an open system the temperature of wollastonite formation decreases slightly with rising pressure (at 506 MPa  $P_{\text{CO}_2}$  the temperature is about 420°C). Triclinic  $\alpha$ -wollastonite forms at 450°C and almost any pressure, and converts into triclinic pseudowollastonite ( $\beta$ - $\text{CaSiO}_3$ ) at 1,120 - 1,160°C. This occurs only in synthetic wollastonite products in ceramics, slags, cin-

Table 189

### Wollastonite

Minerals	Formula	Color/Luster	SG	H	Crystal system/ habit	Occurrences
Wollastonite for William Hyde Wollaston (1766-1828), English chemist and mineralogist	$\text{CaSiO}_3$ 48.3% CaO 51.7% $\text{SiO}_2$	White, yellowish; vitreous to pearly luster	2.8 - 2.9	4.5 - 5.0	coarsely bladed crystalline masses that break down into acicular cleavage fragments	contact metasomatic or skarn; detrital deposits
Pseudo-wollastonite	$\beta$ - $\text{CaSiO}_3$ 48.3% CaO 51.7% $\text{SiO}_2$	Colorless; transparent, vitreous	2.9	5	triclinic; equant grains, twinning	pyrometamorphosed Tertiary rocks

Source: various including Roberts et al., 1990