**Mica:**

Mica, any of a group of hydrous potassium, aluminum silicate minerals. It is a type of phyllosilicate, exhibiting a two-dimensional sheet or layer structure. Among the principal rock-forming minerals, micas are found in all three major rock varieties—igneous, sedimentary, and metamorphic.

**General Considerations**

Of the 28 known species of the mica group, only 6 are common rock-forming minerals. Muscovite, the common light-coloured mica, and biotite, which is typically black or nearly so, are the most abundant. Phlogopite, typically brown, and paragonite, which is macroscopically indistinguishable from muscovite, also are fairly common. Lepidolite, generally pinkish to lilac in colour, occurs in lithium-bearing pegmatites. Glauconite, a green species that does not have the same general macroscopic characteristics as the other micas, occurs sporadically in many marine sedimentary sequences. All of these micas except glauconite exhibit easily observable perfect cleavage into flexible sheets. Glauconite, which most often occurs as pelletlike grains, has no apparent cleavage.

The names of the rock-forming micas constitute a good example of the diverse bases used in naming minerals: Biotite was named for a person—Jean-Baptiste Biot, a 19th-century French physicist who studied the optical properties of micas; muscovite was named, albeit indirectly, for a place—it was originally called “Muscovy glass” because it came from the Muscovy province of Russia; glauconite, although typically green, was named for the Greek word for blue; lepidolite, from the Greek word meaning “scale,” was based on the appearance of the mineral’s cleavage plates; phlogopite, from the Greek word for firelike, was chosen because of the reddish glow (colour and lustre) of some specimens; paragonite, from the Greek “to mislead,” was so named because it was originally mistaken for another mineral, talc.

**Chemical Composition**

The general formula for minerals of the mica group is XY2–3Z4O10(OH, F)2 with X = K, Na, Ba, Ca, Cs, (H3O), (NH4); Y = Al, Mg, Fe2+, Li, Cr, Mn, V, Zn; and Z = Si, Al, Fe3+, Be, Ti. Compositions of the common rock-forming micas are given in the table



Few natural micas have end-member compositions. For example, most muscovites contain sodium substituting for some potassium, and diverse varieties have chromium or vanadium or a combination of both replacing part of the aluminum; furthermore, the Si:Al ratio may range from the indicated 3:1 up to about 7:1. Similar variations in composition are known for the other micas. Thus, as in some of the other groups of minerals (e.g., the garnets), different individual pieces of naturally occurring mica specimens consist of different proportions of ideal end-member compositions. There are, however, no complete series of solid solutions between any dioctahedral mica and any trioctahedral mica.

**Crystal Structure**

Micas have sheet structures whose basic units consist of two polymerized sheets of silica (SiO4) tetrahedrons. Two such sheets are juxtaposed with the vertices of their tetrahedrons pointing toward each other; the sheets are cross-linked with cations—for example, aluminum in muscovite—and hydroxyl pairs complete the coordination of these cations (see figure). Thus, the cross-linked double layer is bound firmly, has the bases of silica tetrahedrons on both of its outer sides, and has a negative charge. The charge is balanced by singly charged large cations—for example, potassium in muscovite—that join the cross-linked double layers to form the complete structure. The differences among mica species depend upon differences in the X and Y cations.

Although the micas are generally considered to be monoclinic (pseudohexagonal), there also are hexagonal, orthorhombic, and triclinic forms generally referred to as polytypes. The polytypes are based on the sequences and number of layers of the basic structure in the unit cell and the symmetry thus produced. Most biotites are 1M and most muscovites are 2M; however, more than one polytype is commonly present in individual specimens. This feature cannot, however, be determined macroscopically; polytypes are distinguished by relatively sophisticated techniques such as those employing X-rays.

The micas other than glauconite tend to crystallize as short pseudohexagonal prisms. The side faces of these prisms are typically rough, some appearing striated and dull, whereas the flat ends tend to be smooth and shiny. The end faces are parallel to the perfect cleavage that characterizes the group.

**Physical Properties**

The rock-forming micas (other than glauconite) can be divided into two groups: those that are light-coloured (muscovite, paragonite, and lepidolite) and those that are dark-coloured (biotite and phlogopite). Most of the properties of the mica group of minerals, other than those of glauconite, can be described together; here they are described as pertaining simply to micas, meaning the micas other than glauconite. Properties of the latter are described separately later in the discussion.

The perfect cleavage into thin elastic sheets is probably the most widely recognized characteristic of the micas. The cleavage is a manifestation of the sheet structure described above. (The elasticity of the thin sheets distinguishes the micas from similarly appearing thin sheets of chlorite and talc.) The rock-forming micas exhibit certain characteristic colours. Muscovites range from colourless, greenish to blue-green to emerald-green, pinkish, and brownish to cinnamon-tan. Paragonites are colourless to white; biotites may be black, brown, red to red-brown, greenish brown, and blue-green. Phlogopites resemble biotites but are honey brown. Lepidolites are nearly colourless, pink, lavender, or tan. Biotites and phlogopites also exhibit the property termed pleochroism (or, more properly for these minerals, dichroism): When viewed along different crystallographic directions, especially using transmitted polarized light, they exhibit different colours or different absorption of light or both.

The lustre of the micas is usually described as splendent, but some cleavage faces appear pearly. The minutely crystalline variety consisting of muscovite or paragonite (or both), generally referred to as sericite, is silky.

Mohs hardness of the micas is approximately 21/2 on cleavage flakes and 4 across cleavage. Consequently, micas can be scratched in either direction with a knife blade or geologic pick. Hardness is used to distinguish micas from chloritoid, which also occurs rather commonly as platy masses in some metamorphic rocks; chloritoid, with a Mohs hardness of 61/2, cannot be scratched with a knife blade or geologic pick.

Specific gravity for the micas varies with composition. The overall range is from 2.76 for muscovite to 3.2 for iron-rich biotite.

Glauconite occurs most commonly as earthy to dull, subtranslucent, green to nearly black granules generally referred to as pellets. It is attacked readily by hydrochloric acid. The colour and occurrence of this mineral in sediments and sedimentary rocks formed from those sediments generally are sufficient for identification.

**Origin and Occurrence**

Micas may originate as the result of diverse processes under several different conditions. Their occurrences, listed below, include crystallization from consolidating magmas, deposition by fluids derived from or directly associated with magmatic activities, deposition by fluids circulating during both contact and regional metamorphism, and formation as the result of alteration processes—perhaps even those caused by weathering—that involve minerals such as feldspars. The stability ranges of micas have been investigated in the laboratory, and in some associations their presence (as opposed to absence) or some aspect of their chemical composition may serve as geothermometers or geobarometers.

Muscovite is particularly common in metamorphic gneisses, schists, and phyllites. In fine-grained foliated rocks, such as phyllites, the muscovite occurs as microscopic grains (sericite) that give these rocks their silky lustres. It also occurs in some granitic rocks and is common in complex granitic pegmatites and within miarolitic druses, which are late-magmatic, crystal-lined cavities in igneous rocks. Much of the muscovite in igneous rocks is thought to have been formed late during, or immediately after, consolidation of the parent magma. Muscovite is relatively resistant to weathering and thus occurs in many soils developed over muscovite-bearing rocks and also in the clastic sediments and sedimentary rocks derived from them.

Paragonite is known definitely to occur in only a few gneisses, schists, and phyllites, in which it appears to play essentially the same role as muscovite. It may, however, be much more common than generally thought. Until fairly recently nearly all light-coloured micas in rocks were automatically called muscovite without checking their potassium:sodium ratios, so some paragonites may have been incorrectly identified as muscovites. Its weathering is essentially the same as that of muscovite.

Lepidolite occurs almost exclusively in complex lithium-bearing pegmatites but has also been recorded as a component of a few granites.

Glauconite, as noted above, is forming in some present-day marine environments. It also is a relatively common constituent of sedimentary rocks, the precursor sediments of which were apparently deposited on the deeper parts of ancient continental shelves. The name greensand is widely applied to glauconite-rich sediments. Most glauconite occurs as granules, which are frequently referred to as pellets. It also exists as pigment, typically as films that coat such diverse substrates as fossils, fecal pellets, and clastic fragments.

**Uses**

Because of their perfect cleavage, flexibility and elasticity, infusibility, low thermal and electrical conductivity, and high dielectric strength, muscovite and phlogopite have found widespread application. Most “sheet mica” with these compositions has been used as electrical condensers, as insulation sheets between commutator segments, or in heating elements. Sheets of muscovite of precise thicknesses are utilized in optical instruments. Ground mica is used in many ways such as a dusting medium to prevent, for example, asphalt tiles from sticking to each other and also as a filler, absorbent, and lubricant. It is also used in the manufacture of wallpaper to give it a shiny lustre. Lepidolite has been mined as an ore of lithium, with rubidium generally recovered as a by-product. It is used in the manufacture of heat-resistant glass. Glauconite-rich greensands have found use within the United States as fertilizer—e.g., on the coastal plain of New Jersey—and some glauconite has been employed as a water softener because it has a high base-exchange capacity and tends to regenerate rather rapidly.