# Vermiculite

$(Mg,Fe++,Al)_3(Al,Si)_4O_{10}(OH)_2 \cdot 4(H_2O)$

*In commerce, vermiculite which expands more than 10 times the original volume is regarded of good quality. With an expansion below 10 times the original volume, vermiculite is considered of low grade.*

## The History Says

It is believed that the mineral, now known as vermiculite, was originally observed in Worcester, Massachusetts, in 1824. When exposed to a flame, the mineral would expand into a variety of fanciful forms resembling small worms. Because of this peculiar property, Thomas H. Webb gave it the name vermiculite, or worm breeder.

## The Present Scenario

Vermiculite plaster is widely used for better acoustics and reduction of noise in auditoriums, wireless studios, theatres, hospitals etc. Vermiculite mixed with three parts of gypsum is used as plaster for sound-absorbing purposes.

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VERMICULITE is the name used in commerce for a group of micaceous minerals that expand or exfoliate many times (commercial varieties esfoliate 8 to 20 times or more) the original thickness when heated. They show the characteristic micaceous structure of basal cleavage and occur as soft, pliable inelastic laminae. Their basal cleavages are not so perfect as those of mica. Vermiculite exists in a wide range of colours from black through various shades of brown to yellow. Its chemical composition varies widely consisting of a complex hydrated aluminium, magnesium silicate and hence the analysis of the mineral is

of little use in determining the vermiculite for commercial utility; a technical trial of the material provides the only satisfactory test. Vermiculite owes its commercial utility to its property of exfoliation when heated. It exfoliates into a yellow to bronze coloured mass giving an appearance of a cluster of worms - vermiculus, an Italian word for worm from which it has derived its name as vermiculite. Some authorities quote the Latin word vermiculari from which the name vermicultie might have been derived.

| Hardness | Varieties | Chemical/Typical composition | Colour | Common Impurities | Luster | Streak |
|---|---|---|---|---|---|---|
| 1.5-2 - Talc-Gypsum | • Batavite<br>• Copper Vermiculite<br>• Eastonite (of Hamilton)<br>• Lucasite (of Chatard) | Silica,31-41% Alumina,10-17% Iron oxides,5-22% Magnesium oxide,11-13% | Colorless Green Gray white Yellow brown | Ca Na K | Vitreous - Dull | greenish white |

## Properties

Vermiculite crystallizes in the monoclinic system, and the crystal faces are often marked wth triangular lines at 60 degrees and 120 degrees. X-ray studies have indicated that vermiculite constitutes a specific

type with a definite structure differing from that of mica or chlorite. From the tabulation of a number of analyses, Gruner has stated that its average composition can be represented by the formula $22MgO.5Al_2O_3, 22SiO_2. 40H_2O$ whereas J. B. Myers gives the structural formula as $(OH)_2. (Mg,Fe)_3 (Si, Al, Fe)_4.O_{10}.4H_2O$. The indefinite and variable chemical composition of vermiculite is indicated by the following ranges of major constituents in percentages:

- Silica, 31-41
- Alumina, 10-17
- Iron oxides, 5-22
- Magnesium oxide, 11-13
- Total water content (free water and water of crystallization)

Nineteen varieties of vermiculite have been identified and listed. Colloquilly (mostly in England) vermiculite is known as Sunshine, Feather Gold and Golden mica. In Japan, it is known as Leach stone.

Its hardness reanges from 1.5 to 3. The specific gravity of the crude material as mined is about 2.5, fusion point is approximately 1335ºC and specific heat is 0.2. The property of exfoliation together with the development of golden, bronzy or silvery lustre on heating is the outstanding characteristic ofvermiculite. This is one of the most important characteristics by which vermiculite differs from mica. Exfoliation commences from varying temperatures with different samples, in some cases as low as 150ºC. In industrial practice a temperature range between 800ºC-1100ºC (for a period of 4 seconds to 2 minutes) is employed. The exfoliation takes place solely in a direction perpendicular to the cleavage. Exfoliation is said to result from the expulsion of combined water by the purely mechanical effect of the sudden formations of steam. Certain qualities of vermiculite exfoliate and develop lustre when immersed in cold hydrogen peroxide ($H_2O_2$) or other oxidising agents such as a mixture of potassium per

manganate ($K_2MnO_4$) and hydrochloric acid (HCl). In these cases the exfoliation is probably caused by the mechanical force involved in the liberation of oxygen from the reagent by the catalyst present in the vermiculite. It has been suggested that exchangeable magnesium ions present in the water layers are responsible for the liberation of oxygen. The moisture content of the mineral has a bearing on its price, and the combined water content gives an indication of exfoliation properties.

## Industrial Applications

Vermiculite is always used in exfoliated form. When exfoliated it possesses nearly 10 to 11 times less bulk density than the original volume. In commerce, vermiculite which expands more than 10 times the original volume. In commerce, vermiculite which expands more than 10 times the original volume is regarded of good quality. With an expansion below 10 times the original volume, vermiculite is considered of low grade. The low bulk density, comparative high refractoriness, low thermal conductivity and chemical inertness make vermiculite satisfactory for many types of thermal and acoustic insulations. One of its large commercial uses is as an aggregate in light weight concrete and hard wall-plaster because of its acoustic and thermal insulating and fire-resisting qualities. The density of raw vermiculite is 50 to 90 lbs. per cu. ft. While that of the exfoliated one is 5-10 lbs. per cu. ft. It is therefore extensively used in concrete work to save weight. Vermiculite concrete weighs 20-25 per cu. ft. as against and concrete which weighs about 100 lbs. per cu. ft. Vermiculite concrete has the same advantages as concrete made with pumice and perlite. Refractory insulations both in the form of loose vermiculite fill and vermiculite bricks are used in furnaces and kilns up to 1100ºC. About 60% of the present world consumptions is in the form of loose fill when the expanded material is merely pured like dry sand into wall spaces or applied over ceiling constructions or attics of residential buildings with a view to insulating homes against cold in winter and heat in summer. One inch of Unifil, a trade name of a particular expanded vermiculite, holds back as much of 2½ ft. brick wall or wall of concrete 3¾ ft. thick. As a light-w

eight aggregate it is extensively used in prefabricated houses. Vermiculite concrete in the form of monolithic cast is used in sound-absorbing panels in aeroplane engine testing sheds.

Vermiculite, being a granular expanded aggregate with numerous air voids, when mixed with a suitable binder develops sound insulating properties. Vermiculite plaster is widely used for better acoustics and reduction of noise in auditoriums, wireless studios, theatres, hospitals etc. Vermiculite mixed with three parts of gypsum is used as plaster for sound-absorbing purposes. A new building material called Pyrok, consisting of vermiculite bonded with lime and cement is marketed in England.

More than hundred major and minor uses of vermiculite have been developed in the fields of agriculture, pesticides, lubricants, disinfectants, plastics and light-weight insulating bricks.

A canadian steel company ships red hot steel ingots for a distance of 288 km from open hearth to mill plant, embedded in loose vermiculite. A temperature loss of less than 9 per cent is reported. The vermiculite is reused.

Unexfoliated vermiculate has a few minor uses, such as for circulation in drilling mud and in the annealing of steel. When unexfoliated vermiculate is reacted with concentrated $H_2SO_4$, it produces a pure form of silica in flake form. This product is known as 'samisilite'. It is used as adehydrating medium in air conditioning plants since it can absorb about 20 per cent its weight of water. The potency of this product may be revived by heating.