one half to two and one half times as potent as the controls on a volume basis, and one and one half to four times as active on the basis of equal weights of solid in the filtrates.

Preliminary experiments indicate that the active materials, like those from ultra-violet injured yeast cells[4], are characterized by ultra-violet absorption at 2600 A.

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[1] Fardon, Norris, Loofbourow and Ruddy, NATURE, **139**, 589 (1937); Sperti, Loofbourow and Dwyer, *ibid.*, **140**, 643 (1937); *Studies Inst. Divi Thomae*, **1**, 163 (1937); Fardon, Carroll and Ruddy, *ibid.*, **1**, 17 (1937); Loofbourow, Dwyer and Morgan, *ibid.*, **2**, 137 (1938).

[2] Loofbourow and Dwyer, *Science*, **88**, 191 (1938); *Studies Inst. Divi Thomae*, in the press.

[3] Loofbourow and Dwyer, NATURE, **143**, 725 (1939).

[4] Cook, Loofbourow and Stimson, 10th Internat. Congress of Chemistry, Rome, May 1938; Loofbourow, Cook and Stimson, NATURE, **142**, 573 (1938).

Exfoliation of Vermiculite by Chemical Means

SPECIMENS of vermiculite from different localities have been examined in the laboratories of the Mineral Resources Department of the Imperial Institute in the course of an investigation into possible Empire sources of supply, and an interesting phenomenon has been observed in connexion with the expansion of the mineral, a property on which its commercial value depends. This expansion is usually brought about by heating the material, and a record of an instance in which it has been effected by chemical treatment appears to be of scientific interest.

It has been noticed that in the mechanical analysis of soils, the preliminary treatment with hydrogen peroxide causes some alteration in the appearance of weathered mica particles present in the soil. This suggested that hydrogen peroxide might have some action on vermiculite, and in order to ascertain its effect a number of small pieces of the mineral, about ½ inch in diameter and less than 1/10 inch in thickness, were covered with the reagent (20 vol. strength) and allowed to stand. Complete exfoliation takes place after some time in the cold and can be hastened by gentle heating. A preliminary drying of the mineral at 100° C. was found to accelerate the action in one instance. The treated specimens have a concertina-like appearance, the lamellæ forming the bellows, and with one specimen alternate light and dark coloured zones were observed parallel to the direction of expansion, which is curved. The material treated with hydrogen peroxide is of a paler colour than that exfoliated by heat, and provided that it is kept moist, is also very soft, requiring only gentle rubbing or stirring, rather than grinding, to reduce it to a fine state of subdivision. The mechanical strength of the treated and still moist product is low, but after drying in a steam oven, its properties are similar to those of the heat-treated material.

The exact cause of this effect has not yet been ascertained. It has always been considered that the exfoliation of vermiculite on heating is due to the separation of individual lamellæ by the evolution of combined water, but this would not explain the similar effect obtained with hydrogen peroxide. The effect obtained may possibly be due to evolution of oxygen between the flakes of the mineral, but this does not explain the asymmetric expansion or the zones of different colour.

Various other oxidizing and reducing agents (potassium permanganate, potassium dichromate, chromic acid, sodium hypobromite, chlorine generated from permanganate and hydrochloric acid, water saturated with sulphur dioxide) have been tried, but none of them has given an expansion at all comparable with that obtained with hydrogen peroxide, although some effect was observed in certain instances after long standing. Chlorine from permanganate and hydrochloric acid, for example, causes a certain amount of exfoliation and separation of the lamellæ but not to the extent given by hydrogen peroxide.

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Technique of the Painting Process in the Bagh Caves in Gwalior State

THE Bagh caves (lat. 22° 22′ N., long. 74° 48′ E.) are situated among the southern slopes of the Vindhya Hills, seventy miles from Mhow, a town on the Rajputana-Malwa section of the B.B. and C.I. Railway. The caves were at one time fully decorated with paintings. But there are remains of them[1] only in caves III and IV. The caves, which are of sandstone, have crumbled, due to the excessive weight of the superimposing band of claystone with moisture percolating through it. Consequently many of the paintings have disappeared. The paintings probably belong to the early seventh century A.D.[2], being contemporaneous with the paintings in Caves XVI and XVII at Ajanta.

The paintings of Bagh and Ajanta form a class by themselves. They belong to the golden age of Indian classical art, which inspired more than half the art of Asia. They will bear comparison with the best that Europe could produce down to the time of Michelangelo[3].

In the course of my studies[4] on Indian paintings, I recently investigated the methods and materials used by the classical artists at Bagh. The paintings are done on the sandstone wall of the veranda lining Caves IV and V. The painted stucco consists of rough plaster of ferruginous earth or of lime. The earth plaster has a thin smooth coat of a mixture of gypsum and lime. The lime plaster has a thin coat of limewash. These thin coats support the layer of paint. The rough plasters of earth and of lime vary in thickness from 7·9 mm. to 20 mm. and from 3·4 mm. to 6·5 mm. Their average thicknesses are 17 mm. and 4·9 mm. respectively. With the earth stucco, the gypsum-lime layer and the paint layer are each 0·1 mm. thick. In the lime stucco, the limewash and the paint film are each 0·2 mm. thick. 48 per cent of the deep red plaster is composed of particles the sizes of which vary from 200 μ to 700 μ, while 16 per cent of them are less than 200 μ and 36 per cent greater than 700 μ. The corresponding figures for the light red earth plaster and the lime plaster are 40, 20, 40 per cent and 40, 60, 0 per cent respectively.