To determine whether drug treatment could influence the course of EAE after its onset, guinea pigs were sensitized and, as signs appeared, animals were either treated with methotrexate or served as controls. The animals were numbered and were assigned to either the treated or the control group at the time of sensitization and the two groups were considered to be closely matched. The mean weight loss for the 24 hours preceding the appearance of signs of EAE was 38.4 g for the control group and 41.6 g for the treated group. Methotrexate was given for a 2- to 3-week period from the day of onset of disease. For the first 3 to 6 days 10 mg was injected daily, and thereafter, 5 mg was injected daily. The mortality rate in the control group over the 2-week period after onset of the disease was 85 percent (23 of 27 animals) whereas the rate in the methotrexate-treated group was 33 percent (10 of 30 animals). All animals dying in the control group did so within 9 days of onset. During the period of drug administration none of the treated animals died later than 5 days after the onset. The death rate in the two groups was similar at the third day after onset of disease. From the fourth day however, a clear difference in mortality emerged. The surviving animals showed weight gain and improvement or reversal of paralysis. Twenty of the treated animals were studied for more than 4 weeks after treatment with methotrexate was stopped. There was temporary weight loss and worsening of paralysis in six of these animals. Three others became worse and died with EAE from 8 to 16 days after the last dose of a 2-week course of methotrexate. These three deaths occurred from 21 to 29 days after the onset of signs of the disease.

Hoyer *et al.* have reported similar suppression of the production of EAE in rabbits and guinea pigs with the antimetabolite 6-mercaptopurine (*3*). However, no effect of 6-mercaptopurine was seen when administration was begun after the onset of disease. The toxicity of 6-mercaptopurine appeared to be considerable, although it was felt not to be important as a nonspecific factor in the inhibition of EAE. The mechanism of action of these drugs in such inhibition is as yet uncertain. Although 6-mercaptopurine and methotrexate both suppress antibody production, the role of circulating antibody in the pathogenesis of this disease is disputable. Suppression of the inductive or proliferative cellular changes associated with the production of circulating antibody or with the development of the delayed hypersensitive state may be important. The possibilities of an anti-inflammatory action or of still other effects have not been ruled out.

Experimental allergic encephalomyelitis is a useful experimental model for human demyelinating diseases such as postinfectious encephalomyelitis and multiple sclerosis. In any consideration of the use of methotrexate in humans with diseases that might have an autoimmune basis, the great variation in susceptibility of different species to the toxic effects of methotrexate is important. In the human, doses of 0.5 mg/kg of methotrexate daily for 5 days often produce severe toxicity; in contrast, the guinea pig tolerates more than 10 mg/kg daily for at least 2 to 3 weeks with little evidence of toxic effects.

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Montmorillonite-Vermiculite Interstratification in Clays from Eocene Chalk Soils

Abstract. *Soils of the Eocene chalk often show interstratification in their clay fractions, though discrete 14- and 18-Å spacings are the rule rather than the exception. It is also frequent that a 16-Å intermediate shows in place of these diffraction maxima. This intermediate is indicative of complex interstratification. It is a unique feature of this body of soils and a strong indication that existing data on random and regular interstratification are both correct and diagnostic. The rare but interesting diffuse basal spacings which are observed at 22 Å are another unusual feature of the clays of this group of soils.*

Interstratification of vermiculite and montmorillonite occurs in the Prairie soils of northeastern Mississippi, and irregularities are common in the x-ray diffraction patterns. A 16-Å diffraction maximum is found in many of the samples. This sharp, regular, and intense diffraction maximum is one of the best examples of layer-silicate interstratification I have yet found, and the collapse of the materials caused by potassium-saturation and gentle heat treatment is another point of interest. The 14- to 18-Å pair is a more common characteristic of the soils being described, and the unusual cases described here were selected to demonstrate a specific point.

The Houston clay (sampled 7 miles west of Columbus, Mississippi) illustrates the unusual characteristics of some of the soils. Saturation with magnesium and glycerol solvation at room temperature were a part of the sample preparation procedure. The presence of montmorillonite, mica, and kaolinite is evident from the data presented in Table 1. However, the presence of the 16-Å diffraction maximum in coarse clay fractions at all depths and its presence in fine clay taken from the lowest depth sampled are worthy of note. The 16-Å component is probably a weathering product, and in lower layers even the fine clay has a most unusual interstratification. The sharpness of all diffraction maxima suggests that some interstratification may be common in these soils. The presence of accessory minerals was verified by heat treatments and other techniques. Perhaps the most unusual feature of the clays is the dif-

Table 1. X-ray diffraction maxima in various fractions of Houston clay.

Fraction (μ)	Relative intensity at various D-spacings			
	17.6 Å	16.3 Å	10.0 Å	7.1 Å
	Depth 0 to 6 inches			
< 0.2	29		2	6
2–0.2		32	1	28
CC*			23	
	Depth 6 to 12 inches			
2–0.2		26	7	20
	Depth 18 to 24 inches			
2–0.2		27	7	30
CC*			20	
	Depth 24 to 30 inches			
< 0.2	20			4
	Depth 30 to 36 inches			
< 0.2		34	4	10
2–0.2		19	4	10
CC*			14	

*Coarse clay, potassium-saturated samples heated to 500°C.

Table 2. X-ray diffraction maxima of clays from Eocene chalk soils.

Soil	Relative intensity at various D-spacings		
	22 Å	16 Å	15 Å
Houston		13	
Houston		20	
Hunt			10
Hunt			12
Hunt		16	
Hunt		14	
Vaiden	8		

fering basal spacings that are a function of both particle size and depth.

X-ray diffraction maxima of a group of clays from other chalk soils are shown in Table 2. The 16-Å maximum is apparent, and anomalies such as 15- and 22-Å spacings are also present. These unusual spacings may be interpreted as random interstratifications. It should be mentioned that discrete 14- and 18-Å spacings are the rule in these clays, rather than anomalous spacings. Clays of the Houston, Hunt, and Vaiden soils derived from Eocene chalk show strong indications of interstratification. Diffraction maxima at 22, 16, and 15 Å indicate that the systems are complex. These maxima are usually thought to be indicative of vermiculite-montmorillonite interstratification, but the variable nature of low-angle diffraction maxima leaves one with doubt about the correct interpretation.

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Surface Material of the Moon

Abstract. *A skeletal fuzz that consists mostly of open space probably covers the moon to a depth of several millimeters or centimeters. The solid part of the fuzz probably consists of randomly oriented linear units, with or without enlarged nodes, which either anastomose in a mesh or are branching.*

Light is retrodirected from the surface material of the moon; that is, the moon's surface has the property of backscattering much more light in the direction of the light source than it scatters in other directions (*1*). This inference is the only possible explanation of three otherwise anomalous features of the brightness of the moon: the lack of limb darkening on the full moon, the steepness of the photometric curve for the moon as a whole, and the form of the photometric curves for individual points on the moon, which have maxima at full moon rather than, as theory predicts, when the sun is most nearly overhead, at local noon.

The most probable explanation of the retrodirected light is that it is a shadow effect due to roughness of the moon's surface. According to this hypothesis, already well known half a century ago (*2*), much of the moon's visible surface is in shadow at large phase angles; the individual shadows are much too small to distinguish with even the best telescope, but they darken the surface. As the phase angle decreases, less and less of the area is in shadow, until at 0°, at full moon, each shadow is covered by the object that casts it.

The difficulty with the shadow effect hypothesis has been that no materials familiar on the earth cast nearly enough shadow. Large amounts are required: the moon's light is estimated to decrease roughly 15 percent between phase angles 1½° and 4½° (*3*), and it decreases to less than one-twelfth the full-moon value by quadrature (*4*). Fragmental materials such as gravel, sand, or angular blocks can cast only a small fraction of the necessary shadow (*5*), and even scoria fragments, themselves rough and pitted, are insufficient (*6*). It would seem to follow that dust, too, cannot produce the observed retrodirected light. At best dust would be expected to produce no more shadow than the angular blocks, and the photometric curves would be less steep unless the particles were highly opaque; the great majority of minerals and rocks become lighter in color when powdered, as on the streak plate or in a hammer scar. Hapke has recently argued (*6*) that "fairy castles" of dust particles a few microns in diameter might produce the required shadows, but aside from the difficulty with the opacity of such small particles, the "castle" structures he describes depend on electrostatic charges that would presumably decay in a few thousand years, especially under monthly cycles of ionizing radiation from the sun. The structures would therefore lack stability and would collapse.

Other kinds of roughness have also been invoked. Barabashov supposes the moon's surface to be closely seamed with deep cracks and fissures (*7*). Bennett suggested that the surface is covered with hemispheric pits (*8*). Van Diggelen showed that hemi-ellipsoidal pits, with depths greater than their diameters, produce photometric curves more like those produced by the moon (*1*). However, all of these seem to fail at the limb. Consider a point on the moon's equator at 85°E (*9*). There our line of sight is nearly tangent to the surface, and we see only the areas between the cracks or the pits. At local noon, just after first quarter, all these areas should be in full sun, without shadows, and should look brighter than at full moon, not a mere fraction as bright.

The problem, therefore, is to find some kind of geometry that can satisfy the requirements better. These requirements are that the surface material of the moon (i) should provide at least 15 percent of dark shadow at a phase angle of only 4½°, and increasing amounts at increasing phase angles, and (ii) should look essentially the same when it is viewed nearly tangent to the surface, near the limb, as when it is viewed vertically down onto the surface, at the subterrestrial point.

These requirements indicate at least three general facts about the geometry of the material of the lunar surface. First, it must have much open space, because an object cannot cast much shadow at small phase angles on a surface on which it rests; it can do so only on a surface above which it is raised. For example, the maximum area of shadow that a cylinder of radius r can cast at phase angle 4½° on a plane surface on which it rests is $r(\tan 4°30')$, or $0.08r$; that is, 4 percent as much as the projected area of the cylinder (Fig. 1). Thus a series of such cylinders, laid parallel, cannot cast more than about 4 percent of shadow, and that only if they are spaced $2.08r$ apart. Most configurations of equidimensional objects will cast less than that, because in general the objects will be less than spherical, or less than ideally spaced, or on a rough surface on which they will tend to occupy the depressions. However, a series of evenly spaced cylinders 3 diameters apart in planes spaced 3½ diameters apart can show 16 or 17 percent of shadow at phase angle 4½° (Fig. 2), and if randomly spaced or farther apart they could show even more. We can conclude that the lunar material must consist of opaque elements isolated from each other both horizontally and vertically by distances that average several times their diam-