



Fig. 1. Sorption of caesium by calcium- or potassium-saturated illite (Il) and vermiculite (Vr) as a function of time. Caesium sorbed was determined by the difference between the activity of the original and the final solution in contact with the mineral.

experiment consisted of about 90 per cent vermiculite and about 10 per cent interstratified vermiculite-biotite and had an exchange capacity of 140 m.equiv./100 g as determined by the method of Sawhney *et al.*⁶ A 2-0.2 μ fraction of Fithian illite was similarly treated. Sorbed caesium was calculated from the difference between the activity of the caesium solution added and that of the supernatant liquid.

The results (Fig. 1) show that a slight increase in the amount of caesium sorbed by calcium-saturated illite occurred during the first few hours and it then remained constant, while the amount of caesium sorbed by potassium-saturated illite decreased slightly with time. On the other hand, the amount of caesium sorbed by calcium-saturated vermiculite continued to increase with time, while that sorbed by potassium-saturated vermiculite continued to decrease with time. Caesium sorbed by potassium-saturated vermiculite decreased from 82 per cent of added caesium at the end of 2 h to only 59 per cent at the end of 480 h. Further, in neither vermiculite was equilibrium reached even after 500 h. In contrast to this, when free electrolyte was present, equilibrium was reached in less than 24 h (ref. 1). The decrease in caesium sorbed by potassium-saturated vermiculite occurred at 5°, 25° and 80° C. Experiments showed that small amounts of potassium displaced from clay by caesium did not interfere in the determination of caesium-137 activity.

Attempts were next made to find an explanation for this unusual behaviour of potassium-saturated vermiculite. From the decrease in caesium sorbed with time, it is obvious that a maximum of caesium is sorbed very quickly, perhaps instantly, by a potassium-saturated vermiculite. This may change the mineral lattice so that caesium is extruded out of the interlayer edge sites where it is sorbed from dilute solutions¹.

A possibility suggested by J. A. Kittrick is that if potassium-saturated vermiculite in water is partially expanded by some water molecules in the interlayers, then the sorption of a less hydrated ion, caesium, at the interlayer edges of some crystals would bring the layers closer together. This would increase the attraction between the layers and would collapse the lattice. Since potassium would be the dominant interlayer cation and caesium would be only on the interlayer edges of these platelets, their *c*-axis spacing would be 10 Å. And, since caesium has a larger diameter, it will not fit into the collapsed 10 Å spacing, and thus would be extruded out because of the steric effect.

To test this hypothesis, the *c*-axis spacing of potassium-saturated vermiculite to which 10⁻⁴ N caesium chloride had been added, and caesium-saturated vermiculite was determined by X-ray diffraction. Portions from above

vermiculite suspensions were centrifuged, and the colloid was suspended in minimum water. These thick suspensions were transferred to glass slides and X-rayed when wet, just short of flowing. A 'Norelco' X-ray diffraction unit with a flat specimen holder and a wide-range goniometer was used.

Wet potassium-saturated vermiculite had a 23 Å, a 11.5 Å and a 10 Å spacing; the potassium-saturated vermiculite was, thus, found to be partially expanded. No change was detected in these spacings when 10⁻⁴ N caesium chloride was added to potassium-saturated vermiculite. This would be expected, since the sample is still saturated primarily with potassium, and only a small fraction of it has caesium on its interlayer edges. On the other hand, wet caesium-saturated vermiculite had a collapsed 10.8 Å *c*-axis spacing as against a 12 Å observed by Barshad⁷. This supports the postulate that the caesium sorption, by a potassium-saturated and partially expanded vermiculite, brings the layers closer and may, thus, increase the attraction between the layers and collapse the lattice.

The results obtained support the hypothesis that caesium, being a larger ion than potassium, is extruded from the potassium-saturated and collapsed 10 Å lattice of vermiculite, and hence a decrease in sorbed caesium is observed.

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GENERAL

"Significant" and "Highly Significant"

THE proposal by Dr. Miller¹ for quantitatively defined terms for various degrees of probability seems to me to be excellent. I would like to suggest, however, that the word "conclusive" for the case where $P < 0.001$ is undesirable. The term "conclusive" suggests that no further work need be done and that no alternative interpretation is possible. In fact, an industrious person who does a few thousand experiments on the effects of a similar number of different chemicals on a particular biological process will expect to find a few of these apparently giving effects at the $P < 0.001$ level owing to random chance even if none of the chemicals has any real effect at all.

It is almost certain that this occurs from time to time in the pharmaceutical field and little harm is done, at least in informed circles, by the statement that a particular result gives the probability specified, because it will be realized that much work may still be needed before the result can be regarded as genuinely established. If the term "conclusive" were used in the scientific literature at this stage, however, it could have a most undesirable result. When used in the advertising sense to the general public the word "conclusive" really cannot be expected to mean anything except conclusive. The word "decisive", though this case is not quite so serious, does seem also to suffer from the same disadvantage.

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