

## SPACE BETWEEN GRAINS OF SAND.

SIR,—In his article on Miniature Domes in Sand, Mr. Mellard Reade compares (p. 22) the interstitial air-space between grains of sand with that between small round shot of uniform size. The former he finds by an experiment to be about five-twelfths or  $\cdot 4167$  of the whole volume, the sand therefore occupying seven-twelfths or  $\cdot 5833$ . The proportion of space occupied by the round shot he supposes to be the ratio of a sphere to its circumscribing cube, that is,  $\cdot 5236$ . This assumes that the shot arrange themselves in "square order," that is, adjacent shot have their centres at the corners of a cube and each shot touches six others; but in reality they would be more closely packed, falling into what may be called "pyramidal order," in which the centres of adjacent shot are at the corners of a regular triangular pyramid and each sphere is in contact with twelve others. The shot will then occupy  $\cdot 7405$  of the whole volume, leaving only  $\cdot 2595$  for air. Sand is therefore much less compact than small round shot; this is probably due partly to the inequality in the sizes of grains of sand, but mainly to their irregular shape. Perhaps the degree of compactness of any particular kind of sand, determined as in Mr. Reade's experiment, might serve as an index of how far the grains have been rounded by attrition.

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## THE PERMIAN-TRIAS QUESTION.

SIR,—Will you oblige me with space for one or two brief remarks by way of a rider to M. Marcou's paper on the "Permian-Trias Question," in the March Number of the *GEOL. MAG.*? The letter of mine in the January Number, to which M. Marcou refers, was intended merely to point out that although the name "Permian" might possibly continue to be of value as a *local* name for the rocks of that age in the Russian area, it was not only undesirable, but even misleading, as a term for Europe in general. Of course, if, by general consent, the great cupriferous series of sandstones and marls, which overlie the true Dyassic strata in European Russia, be assigned to the Trias, the name "Permian" ceases to have any accurate meaning even for the Russian series. The only question to my mind is as to the true Triassic age of those sandstones and marls. I suppose that Ludwig, d'Eichwald, and others to whom M. Marcou refers, have seen their way to the elimination of the difficulty presented by the Palæozoic facies of the few plant-remains that are found in the cupriferous sandstones and marls (= Murchison's 'Upper Permian'); but until this difficulty is removed, it seems safer to regard these strata (which have no equivalents in Britain or Central Europe) as a *transition-series* between the Dyas and Trias. This idea, to say the least, ought not to be overlooked in any future mapping of the Russian area.

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