the fourth is in the Phalanx Trombidia and possibly a member of the family Microthrombidiidae. Representatives of both of these mite groups have been noted on extant adult Ceratopogonidae (R. V. Southcott, personal communication).

These mites are typically parasitic only in the larval stage. Later, in the nymphal and adult stages, they live as predators on a range of invertebrates. These examples represent the earliest known fossil records of mite parasitism of invertebrates, as well as animal–animal parasitism in general. They show that biting midges were themselves the victims of parasitism as early as the late Mesozoic.

The specimens (RTMP 92.8.4, 92.8.5, 92.8.6 and 92.8.7) are deposited in the Royal Tyrrel Museum of Paleontology at Drumheller, Alberta.

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Size segregation in powders

SIR — Jullien *et al.*[1] have described a computer simulation method for reorganizing stable close packings of hard spherical particles (see ref. 2). Repeated applications of this technique to a mixture of grains with different sizes cause size segregation. An important consequence of the method[1] is the prediction of a critical size ratio for segregation to occur — in other words, a single large impurity sphere will rise through a bed of smaller spheres only if the impurity is larger than a critical size. This threshold has not been observed in size-segregation experiments (see, for example, ref. 3), and is otherwise unexpected — given the importance of shaking-induced size segregation in industry and technology, it is therefore very important to know whether or not it really exists. To do this, we need to know to what extent the method used by Jullien *et al.*[1] models a real material and a real shaking process.

Undoubtedly, real granular materials are not made from ideal, hard spherical particles but, generally, this model of granular solids has proved to be a qualitatively reliable one and has been used by many others[4]. It is, however, more difficult to make a reliable representation of a shaking process. Generally, 'shaking', in the context of granular materials processing, corresponds to any externally applied, cyclic, incoherent driving force that leads to fluctuating particle configurations. Crucially, during shaking, the particles in a powder experience several different dynamical regimes, for instance the 'grain inertial' and the 'quasi-static' regimes. Although it is impossible to identify all the important features of shaking, a list of essential features would certainly include both the collective nature of the process and its complexity. In other words, not only do many particles respond to the driving force simultaneously but the forces experienced by interior particles are complex functions of both the granular structure and the coupling with the applied force. Both of these features are absent from the model studied by Jullien *et al.* which, therefore, is not a realistic representation of a shaking process.

The relatively simple, sequential method of ref. 1 can certainly produce size segregation, but this does not correspond to size segregation induced by shaking. For this reason the size threshold for segregation reported by Jullien *et al.* is not relevant to real shaking experiments (for example, ref. 3) and may be of no practical importance. In fact many counterexamples, where particles of similar sizes segregate during shaking experiments, have been observed (for example, ref. 3) and simulations which include elements that attempt to model the complexity of shaking (for example, the Monte Carlo method proposed by Rosato *et al.*[5]) do not show any size threshold.

The computer modelling of real granular materials is a burgeoning area of research, which is of increasing scientific and technological importance. In particular, the response of powders to vibration is an area of considerable interest, so it is crucial to incorporate the essential physics in any realistic models of this process. The absence, therefore, of non-sequential (cooperative) particle motions and complexity (which are essential features[6,7] of shaking processes in powders) in the work of Jullien *et al.* renders several of their conclusions inappropriate in the context of real shaken granular materials.

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More bubbles in volcanic systems

SIR – After my recent Scientific Correspondence about bubbles in volcanic systems[1], it was brought to my attention that similar arguments had been independently made by some Russian geologists, A. Steinberg, G. Steinberg and A. Merzhanov, some years ago. After some searching, I found their excellent but unfortunately poorly circulated articles[2–5]. They had indeed done a very similar conceptual and experimental analysis, unbeknown to myself, my colleagues, the reviewers of my manuscript and the editors of *Nature*.

Although the discovery of their prior work causes me some consternation, our independent reproduction of the effect further demonstrates the validity of the bubble overpressure effect, as well as its applicability to volcanic systems. Neither they nor we have solved all of the problems related to bubble overpressure in volcanic systems, but since the effect is clearly relevant, the application to volcanic systems can be further quantified on the basis of magma compressibility, gas solubility[5], edifice inflation and leakage of volatiles by pure gas release.

I would like to (belatedly) bring this fine work to the attention of the 'western' volcanological community, and I hope that further duplication of scientific effort can be reduced in the future by closer communication and collaboration between Russian and 'western' scientists.

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