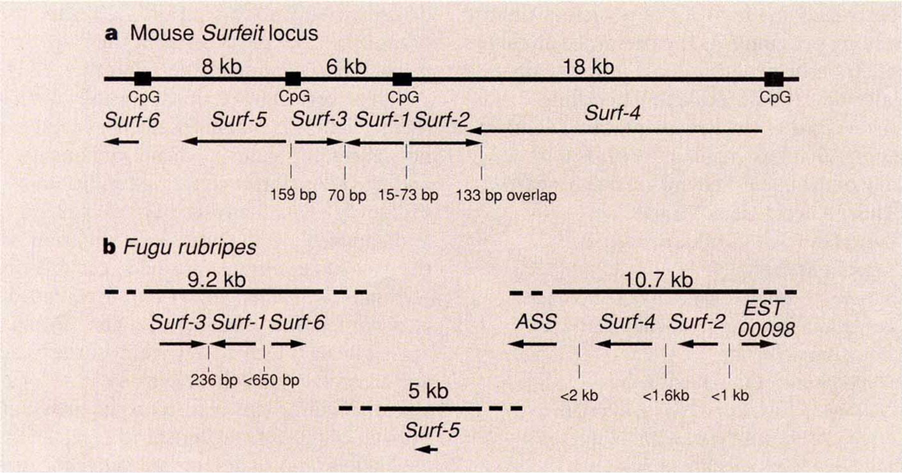

Figure 1 **Comparison of genomic organization of the *Surfeit* genes in mouse and *Fugu*. a, The mouse *Surfeit* locus (modified from ref. 16). Continuous line represents genomic DNA; distance between the genes is shown and the direction of transcription is indicated by arrows. The 5′ end of each gene is associated with a CpG island (boxes). Organization and juxtaposition of the *Surfeit* genes is conserved in humans[6,7], and the human *Surfeit* locus is located at chromosome band 9q34.1 (ref. 7). b, Organization of the *Surfeit* gene homologues, *ASS* homologue and conserved *EST00098* in *Fugu* shown as three separate loci based on cosmid contigs and DNA sequencing. The sequenced genomic regions are represented by continuous lines with the number of kilobases sequenced and the distances between the coding regions of the genes indicated. The direction of transcription of each of the homologues is shown by arrows.**

about 2 megabases from the *Surfeit* locus[12], and *EST00098* has also been mapped to human chromosome 9 (ref. 13). Our polymerase chain reaction analysis shows that *EST00098* is not located within 40 kilobases of either side of the human *Surfeit* locus.

The *Fugu Surf-5* gene is the only *Surfeit* gene homologue found at a third separate locus. Sequences upstream of *Fugu Surf-5* and *Surf-3* and downstream of *Surf-5* and *Surf-6* are not significantly similar to any sequences in the GenBank database.

Comparative Southern-blot analysis of *Fugu* genomic DNA and cosmid DNA reveals that the cloned DNAs analysed are not rearranged with respect to their true genomic organization, and that the *Fugu* gene homologues all have a single copy in the genome. We have accurately positioned the *Fugu* homologues within each cosmid relative to vector arms, using detailed restriction-enzyme mapping and Southern-blot analyses, and find that none of the unrelated cosmid overlaps. Preliminary construction of cosmid contigs around each of the three *Fugu Surfeit* gene loci demonstrates that they must be separated by between 60 and 100 kilobases in the *Fugu* genome, if not located at completely different chromosomal locations. The inability to link the cosmids in a contig suggests that the three clusters are relatively isolated, despite the condensed nature of the *Fugu* genome.

Our results show that the genomic organization of the six *Surfeit* genes, the *ASS* gene and *EST00098* are different in *Fugu* and mammals. Our observations suggest that local DNA rearrangements, such as small inversions, have been common in one or both lineages that gave rise to *Fugu* and mammals. They also show that comparative gene order is so often different between *Fugu* and mammals that it cannot be assumed with confidence that genes that are linked in *Fugu* will also be linked in mammalian genomes. The human *Surfeit* locus genes are located within the candidate region for tuberous sclerosis 1 disease gene[7] and the ASS gene is linked to the loci for nail-patella syndrome[14] and idiopathic torsion dystonia[15]. Our observations bring into question the use of the compact *Fugu* genome as a tool to accelerate the identification of these or other human disease genes using comparative mapping or positional cloning strategies.

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Emplacement of Taupo ignimbrite

Dade and Huppert[1] present a model for emplacement of the Taupo ignimbrite (New Zealand) from a turbulent dilute pyroclastic current (0.3% solids by volume). This model contrasts sharply with that of a concentrated current (tens of per cent solids by volume) previously proposed by me[2] to explain this remarkable deposit. Differences between the two models are important for how ignimbrites are interpreted and in reconstructing their causative eruptions, and centre around two key contrasting views of the Taupo pyroclastic current.

The first is that the model in ref. 1 has the current driven by the momentum of the overall dilute system, whereas my model implicitly has the current driven primarily by momentum of the concentrated basal portion. In my model, an overlying dilute cloud is considered to have still been present but to have represented the product, not the driver, of the concentrated basal portion. Second, in ref. 1, turbulence in the current is *required* to transport particles, whereas in my model, turbulence is only one of several possible particle support mechanisms during transport, including grain–grain interaction, buoyancy effects, matrix support and fluidization[3]. The key distinction between the models is thus in evidence for the value and distribution of solids concentration in the current, not the presence or otherwise of turbulence. In this regard, three aspects of ref. 1 are not soundly based when measured against the data that I presented in ref. 2.

First, the apparent match between modelled and measured parameters in the ignimbrite presented in Fig. 2a–c of ref. 1 is not real. Dade and Huppert use my estimate of the whole-ignimbrite grain-size distribution (Fig. 57 of ref. 2) as the initial input for their model, but match their predictions to data from only one portion of the ignimbrite, the layer-2 veneer facies, previously emphasized[2,4] to be unrepresentative. Compared with the whole ignimbrite, the veneer is depleted in coarse lithics (found in layer 1) and pumices (found in layer-2 ponded facies). To test Dade and Huppert's theory against observations requires measurements of lateral variations in the deposit as a whole. On the other hand, vertical and lateral grain-size variations seen in the Taupo ignimbrite are consistent with deposition from a concentrated current with varying degrees of fluidization and turbulence[2].

Second, Dade and Huppert's model fails to account for four key features of the ignimbrite, considered critical in establishing my model. One of these is the presence of the fines-rich, pumiceous layer 1(P), overlain by the fines-poor lithic-rich layer 1(H), then by the fines-rich, pumiceous layer-2 deposits, all emplaced with a strong lateral velocity component. The ignimbrite thus cannot simply be the result of particle fallout from a turbulent dilute suspension as these three layers, individually or collectively, show no systematic vertical ordering by any grain-size or inferred aerodynamic characteristic applicable in gaseous suspensions.

Another feature of my model is that field and grain-size evidence indicates that many fluidization-segregation bodies in the ignimbrite formed within a moving concentrated current (for example, sedimenting to form the widespread, regionally distributed layer 1(H); ref. 5) and not simply after the flow had come to rest. Observations[2] and experimental data[6,7] imply that these segregation bodies can only form within concentrated systems.

Furthermore, there are marked changes in the fines and lithic contents of ponded layer-2 deposits at 55–60 km from the vent. These changes are qualitatively consistent with the model adopted for a concentrated stratified flow[2], but cannot be explained by interaction of a dilute current with the topography (as suggested in ref. 1), as the changes occur along flat as well as mountainous flow paths.

Finally, field and grain-size evidence in the ignimbrite argues for a more dilute and highly turbulent current in proximal areas ($\leqslant$13–20 km from the vent)[2], for example, abundant megaripples in the layer-2 veneer deposits, lack of systematic grading in layer-2 valley ponds, scarcity of layer 1(P) deposits, and so on. The contrast between these proximal features and those seen elsewhere in the Taupo ignimbrite (which match those seen in numerous other 'conventional' ignimbrites[3]) supports the concept of a concentrated transport system for most of the travel distance of the current.

Third, the claimed matching of pumice:lithic size ratios in the ignimbrite with theory (Fig. 1 of ref. 1) is false. With the reasonable estimates of pumice and lithic densities given by Dade and Huppert, the W_b/W_l ratio in the ignimbrite (both as a whole and in individual facies) is not uniform at about 1.0 as they imply, but varies from <0.2 in proximal areas ($\leqslant$20 km), through 0.5 to 3 in medial (20–55 km) areas to 0.5–1 in distal areas (>55 km), based on my data used in ref. 2 (here W_b/W_l is the ratio of the settling velocity of the largest pumice fragments to that of the lithic fragments). Pumice and lithic sizes (all lithics measured for ref. 2 were demonstrably vent-derived) in the ignimbrite do not match aerodynamically for a dilute suspension.

In summary, the field and grain-size evidence available from the Taupo ignimbrite rule out the model in ref. 1, and imply that the Taupo flow was concentrated for most of its travel distance. A chief weakness of Dade and Huppert's model is that any exponential variations of parameters with distance from the vent could equally well be modelled by the radial spreading of a concentrated, axisymmetrical current. The principles are similar (preferential or partial sedimentation from poorly sorted material in an axisymmetrical, radially moving transport medium), it is merely that the rates may differ.

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Dade and Huppert reply — The debate on the mechanism of ignimbrite emplacement has been frustrated by lack of quantitative, predictive models for the parent flows. We[1] took Wilson's careful observations on the Taupo deposit[2] and reconstructed the parent flow consistent with the deposit and the assumptions of a model for a dilute, deposit-forming gravity current. The definition of dilute is set by the experimentally established range of applicability of quantitative models for such flows. Using our model, we calculated a near-vent solids concentration of 0.3% by volume, but model trends in deposit characteristics are largely independent of the precise value of this estimate.

The key message of our paper[1] was that our model can be used to predict regional variations in the geometry and sorting of grain sizes in the bulk of the Taupo deposit. Quantitative prediction of the dramatic trends in deposit architecture seen at Taupo, on the other hand, has not yet been demonstrated for a concentrated parent flow. Accordingly, one should carefully reconsider the qualitative interpretation of the Taupo deposit given by Wilson[2], particularly before applying it to this and other ignimbrites of low aspect ratio. We acknowledged in our paper that a more complicated quantitative model is required to explain all the details of the Taupo deposit. In our view, finding fault with some of the details of our paper (which, because of its simplicity, is easy to do) is not useful in the absence of a testable alternative.

In this regard we challenge Wilson to pursue his case. Although it is true that the Taupo ponded facies (layer 2b) is locally enriched in coarse pumice relative to the veneer facies, these layer-2 deposits are otherwise indistinguishable in bulk composition and grain size. Under these circumstances it is not clear what weight should be given to local features in a unit (layer 2b) which, at least morphologically, reflects local depositional conditions. We focused on the landscape-mantling veneer facies because it is broadly representative of the regional conditions that controlled the deposition of layer 2. Layer 2 makes up 82% of the total volume (30.5 km^3) of the Taupo ignimbrite, so we used Wilson's estimate of the initial overall grain-size distribution as an input to the model. The good agreement between the calculated and observed trends shown in Fig. 2 of our paper requires no further justification. For the sake of complete reporting, we presented the lateral trends observed in layer 1, and discussed possible explanations for the differences between layers 1 and 2. We pointed out that the sedimentological differences between layer 1 and the veneer deposit are much greater than the differences between the veneer and layer 2b.

It is unclear whether the general description of lateral trends in sedimentological properties of the Taupo deposit by a quantitative model which provides for abrupt changes at 55–60 km can be justified in a statistically significant way. To the extent to which discontinuities can be resolved, we pointed out that they are not unique to any specific flow regime and could be the result of the effects of stratification in a turbulent parent flow. We also suggested that abrupt sedimentological changes could record the interaction of the parent flow with complex regional topography which, at these distances, comprises ridge-like obstacles that are up to 500–1,000 m above vent level. Application of our model does not require these events, but we note that the lateral extent of hydraulic influence of topography is proportional to its horizontal dimension[8], which can be up to several tens of kilometres in the Taupo region. One could expect to observe secondary and complicated topographic effects not only in layer 2b of the locally controlled ponded facies (where most of the potential discontinuities are seen) but throughout the entire deposit.

Our calculations of W_b/W_l (Fig. 1 of ref. 1) demonstrate the approximate settling equivalence expected for particles deposited from a dilute flow. The calculations are based on our equation 2, which is valid for all particle-settling Reynolds numbers, and the material properties given in our paper. The lateral distributions of the maximal sizes of lithics are given by expressions in the captions of Figs 9 and 37 of ref. 2. The lateral distribution of maximal size of pumice in layer 2 is given by a 'hand-fitted' envelope to the data in Fig. 39 of ref. 2 and generated in a manner consistent with that used by Wilson for the distribution of lithics. Without doubt, reasonable differences in the values taken for material properties, descriptions of lateral trends in maximal sizes and expression for particle settling speed can result in small differences in W_b/W_l. Wilson's efforts appear to be a case in point. Although Wilson does not give their basis, his calculations demonstrate the approximate settling equivalence of large pumice and lithics in that W_b/W_l is generally near unity. As we noted in our paper, low values of the ratio near the vent probably reflect the scarcity of large pumice in the initial suspension.

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Sound alters visual motion perception

Little is known about how complementary inputs from different senses are coordinated. To explore the perceptual consequences of this coordination, we devised simple visual stimuli whose analogues outside the laboratory ordinarily produce distinctive sounds. Our assay, optimized with visual stimuli whose motion could be seen in either of two ways[1], reveals that sound can alter the visual perception of motion.

A computer displayed two identical objects that moved steadily towards one another, coincided, and then moved apart. This display is consistent with two different interpretations: either, after coincidence, the two objects could have continued in their original directions; or they could have collided and then bounced, reversing directions. Collisions often produce sounds characteristic of the materials and force of the impact[2]. Our experiments determined whether introduction of sounds would promote the perception of bouncing.

The targets, small disks, moved in three different ways. In two conditions the disks paused at the point of their coincidence, for either one frame or two. In another condition the disks moved continuously with no interruption. These visual conditions were presented together with a brief click (2.5 ms; sound pressure level 75 dB) either 150 ms before or after coincidence, or at the point of coincidence. A control condition presented no sound. Each stimulus combination was presented 20 times in random order to ten naive observers. After each trial, the observer reported whether the disks appeared to stream through or bounce off each other.

Sound at or near the point of coincidence promotes perception of 'bouncing' compared with the control condition (see Fig. 1; repeated measures analysis of variance, $P < 0.0001$). A sound just before visual coincidence has nearly as much effect as a sound at coincidence, but a sound after coincidence has significantly less effect ($P < 0.01$), although it still enhances the perception of bouncing. There is considerable tolerance for asynchrony between sound and visual inputs: even when the sound is delayed by 150 ms after coincidence, the likelihood of seeing bouncing increases ($P < 0.05$). As others have reported[3,4], the overall proportion of bouncing responses grows with increasing pause duration ($P < 0.001$).

The effect of sound on visual motion could represent some generalized attention effect, evocable by any salient transient. We examined this possibility by testing three conditions with 15 new observers. In one condition, a sound (440 Hz, 100 ms, 80 dB) came on only at the point of coincidence. In another condition the same sound, equally intense, was on for the entire visual display, but was turned off for 100 ms at the moment of coincidence. In the final condition no sound was presented. As before, sound onset significantly increased bouncing reports ($P < 0.01$). However, sound offset produced results indistinguishable from those with no sound at all. This suggests that the sound's impact on visual motion is not the product of heightened attention at the moment of coincidence, but may require an acoustic event that signals a collision between moving objects.

The origin of the effect of sound on visual motion is unknown; it may involve some form of multisensory cells[5] and/or feedback from higher-level, multisensory areas onto primary motion areas[6]. Research combining psychophysics and brain imaging may reveal the nature of this effect, and of audiovisual interactions more generally.

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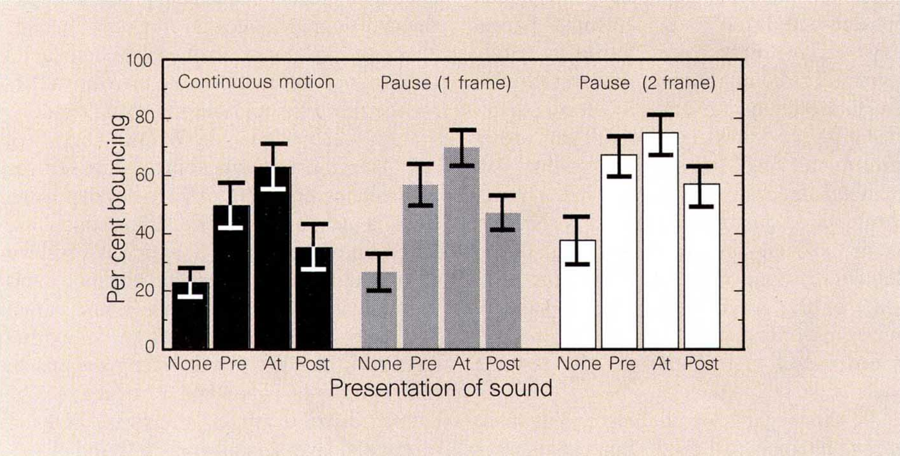

Figure 1 **Percentage of reports of stimulus bouncing. In each trial, two brown disks (visual angle 0.5°, 3.5 cd m^{-2}) appeared on opposite sides of a computer display (white, 95 cd m^{-2}). Initially separated by 4.2°, the disks moved at 6° per s, coincided, then continued across the display. The trial ended when each disk had reached the other's starting position, and both disks disappeared from view (1.4 s). The sequence was viewed binocularly from a distance of 114 cm. Observers indicated whether the disks appeared to stream through or bounce off one another. Black bars, disks moved continuously; grey, one-frame and white, two-frame pause. Motion was accompanied by a brief sound 150 ms before (Pre) or after (Post) the disks coincided, or at the moment of coincidence. On one quarter of the trials, no sound was presented (None). Error bars, ±s.e.m. Full details of methodology and other results available on request from R. S.**

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