corresponding H_{irr} of our $x = 0.6$ crystal was 0.4 T, twice as large as their value. The lack of data at higher temperatures in their report (*3*) prevents us from making a comparison above 50 K. These differences in J_c and H_{irr} at high temperatures must reflect an essential difference in the inherent pinning mechanism between their and our crystals. Wang *et al.* attributed the increase of J_c to the disordering of the modulation, as deduced from the examination of one Pb composition. In contrast, we studied the Pb-doping effects in a systematic way using crystals with different Pb contents from both magnetic and structural points of view and deduced the relation between the enhancement of J_c and the appearance of the specific microstructures. Large enhancements of J_c and H_{irr} were revealed for crystals with Pb content of $x \geq 0.6$ in which a two-phase microstructure appeared. Relatively small but significant increases in J_c and H_{irr} were found for the $x = 0.4$ crystal, but not for the $x = 0.6$ crystal. The minor improvement in the $x = 0.4$ crystal must have another origin, such as reduction in anisotropy, generation of point defects, or a disorder in the modulation as pointed out by Wang *et al.* (*3*).

Our work clearly demonstrated that the flux pinning is dramatically enhanced even at 50 to 60 K, at which point the specific, Pb-content–alternating microstructure appears.

Lieber and Yang referred to the transmission electron microscopy (TEM) study by Chen *et al.* (*4*), where a striped domain structure was described. But these stripes were parallel to the [110] or [210] direction. This was not the case in our TEM observations, where the domain interface was always perpendicular to the [010] direction. Also, we noted the absence of any modulations in every second stripe. No comments were made by Chen *et al.* on the relation between the domain structure and the nature of modulation. It is difficult to find any definite relation between their TEM results and ours. Chen *et al.* (*4*) do not discuss J_c.

Finally, concerning the STM results by Lieber's group, we are not convinced that STM experiments can really detect inhomogeneity or disorder inside crystals. It is only a cleaved surface that is examined by this method. There are no guarantees that a BiO layer keeps its original properties after the counter BiO layer is removed.

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■

A Hill of Beans

Alexander L. Densmore *et al.* (Reports, 17 Jan., p. 369) address an important geomorphologic question: What is the relative importance of large, infrequent, slope-clearing events (SCEs) in determining hillslope longitudinal profiles? To model the frequency and magnitude distribution of SCEs, they filled a narrow [2.5-centimeter (cm)] flume with red beans, slowly lowered an outlet on one end to simulate an incising river, and recorded the resulting mass flux from their simulated hillslope with each 0.5-cm drop in base level. While occurring only 10% of the time, SCEs in their flume accounted for 70% of the total mass removed from the landscape. Between individual SCEs, smaller events developed steep "inner gorges" that were eventually cleared by the next SCE, which suggests that similar features in natural landscapes reflect SCE frequency, not changes in river incision rate as typically assumed.

We were intrigued by the results from this simulation of hillslope failure and recreated the bean model in a graduate seminar. Initial results suggested that flume width controlled the frequency and mechanics of failure, so we built a larger model with adjustable dimensions (*1*) to further measure the effects of different boundary conditions. As flume width increased, SCEs occurred more frequently (Table 1), "inner gorges" vanished, slopes smoothed, and gradient decreased. Unexpectedly, frequency-magnitude changes balanced such that average SCE mass remained roughly constant up to a 10-cm width. Our additional experiments demonstrated that flume width (relative to grain diameter) is a first-order control on failure form, frequency, and magnitude (*2*). Our results confirm previous work (*3*) which showed that the effects of increasing boundary width diminish above six-grain diameters (approximately 10 cm). Boundary conditions, granular interaction, and packing control failure mechanics of granular materials (*4*); particle wedging, bridging, and brick-like stacking one-dimensional to two-all constrained failure in our flume at narrow widths. Boundary effects aside, as grain slopes widened from 1-dimensional to 2-dimensional, lateral noise propagation reduced the self-organized critical slope by amplifying chain reactions (*5*). The physical behavior on which Densmore *et al.* based the geomorphic relevance of their experiments vanished upon widening of the flume in our experiments. Because landslides are generally wide (*6*), the extrapolation made by Densmore *et al.* from the behavior of a hill of beans to bedrock hillslope evolution appears to be unwarranted.

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References and Notes

1. Our steel-framed plexiglass flume measures 38 (length) × 85 cm (high) and adjusts to be up to 25 cm wide. For each width, results were calculated from approximately 200 boundary drops. Red beans averaged 1.74 × 0.80 × 0.51 cm, and our analysis followed that in the report by Densmore *et al.*
2. For narrow widths, flume length and depth also appeared to have had an effect, albeit minor.
3. A. van Burkalow, *Geol. Soc. Am. Bull.* **56**, 669 (1945). At larger widths, our red beans exhibited behavior similar to the smooth slopes reported for white beans in the report by Densmore *et al.*; thus, differences in bean size, not anisotropy, may account for the two modes of behavior reported by Densmore *et al.* for the 2.5-cm flume (*1*).
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Table 1. Experimental variables and results of hillslope failure modeled with red beans.

Width (cm)	Flume width/ bean length	SCEs (%)	Slope (deg)	SCE mass (g) (average)	SCE mass (%)
2.5	1.4	11	37.1 ± 1.7	260 ± 96	66
5	2.9	30	33.7 ± 1.1	213 ± 93	76
10	5.8	49	31.8 ± 0.8	264 ± 135	81
15	8.6	50	32.2 ± 0.5	348 ± 131	78

New Zealand Alps landslides to be approximately elliptical, with an aspect ratio of about 2.0 across all length scales.

Response: Aalto *et al.* properly draw attention to the potential role played by laterally confining stresses in the behavior of dry red beans in response to a falling base level. There are several reasons, however, why their rejection of our interpretations may be premature. The statistics of slides in anisotropic dry beans, in contrast to those in almost-spherical white beans, are similar to the albeit few observational data about landslides (*1*). As in our report, we attribute this behavior to the supporting shear stresses induced by the shape anisotropy of the red beans and draw attention again to experiments with rice (*2*), which showed behavior fundamentally different from that of almost-spherical sand grains. While such statistical agreement is not by itself conclusive, it suggests that real hillslopes are more analogous to those experiments with beans that include some form of supporting shear stresses imparting an integrity or coherence.

The origin of supporting shear stresses and confining normal stresses may be quite diverse and, as suggested by Aalto *et al.*, may arise from the confining walls of our relatively narrow experimental apparatus. By increasing the width of their apparatus, Aalto *et al.* decreased the effects of the walls, creating wide, planar model hillslopes. Real hillslopes are rarely planar, however, and supporting stresses may arise within a ridge and valley topography (*3*), in which the falling base level (for example, an incising river) meanders. Thus, we might expect ridge lines (or spurs) to be sites of relatively less confining normal stresses and hollows (or tributary valleys) to experience greater confining stresses. The degree and variability of channel sinuosity versus the material strength and cohesiveness will presumably influence the behavior of landslides over both space and time. It is also possible that there exist various length scales, even in planar hillslopes, at which failure of the hillslope occurs en masse or in discrete units, the latter yielding inner gorges, the former not. For example, mass wasting along the lee sides of sand dunes is organized into discrete grain flows, despite the planar nature of such slopes (*4*). We expect that bean experiments on a yet wider apparatus would show evidence of such organization. Supporting stresses may also occur in heterogeneous geology or in response to an externally imposed stress field that is still further complicated by fault activity in the upper few kilometers of the crust. Neither our simple model nor that of Aalto *et al.* is capable of addressing these more complex and interesting issues.

Finally, we reiterate that inner gorges are commonly observed features in many mountainous landscapes; they occur at various length scales and at various distances upstream from local base level. It is highly unlikely that the origins of all such inner gorges can be tied to global changes in base level, whether tectonically or climatically controlled. A simpler explanation is that the natural development of hillslopes involves the generation of inner gorges and intermediate scarps, as demonstrated in our experiments.

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Letters to the Editor

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