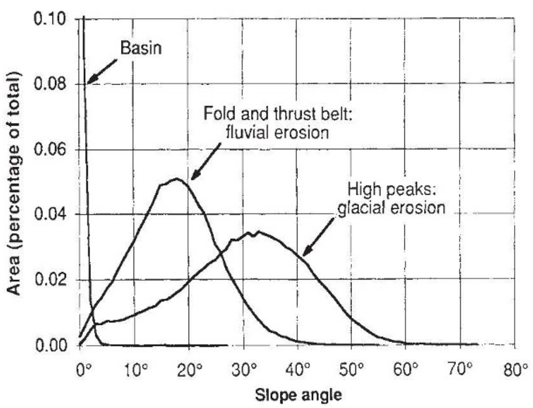

FIG. 2 Distribution of slope angles as a function of position within the Himalayan orogen.

Am. Spec. Pap. **218**, 179–207; 1988). In contrast, topographic relief attains its highest values in the vicinity of the most lofty summits (a not unexpected result), but is nearly equal within the Himalayan foothills and the Tibetan Plateau. This type of topographic analysis has a wide appeal, because it yields data on mean conditions, which are most significant for modellers and geophysicists, as well as on deviations from the mean, quantities of key interest to geomorphologists.

Analogous transects from the Altiplano eastwards to the Andean lowlands reveal similar consistency in the mean topography across the mountains and the adjacent plateau (Fig. 1). Moreover, there is a remarkable coincidence in the slope (5°) of the mean topography from the core of the mountains to the plains in both the Himalayas and Andes, where the average elevation drops from around 5 km to 1.5 km across a span of 40 km. At a more detailed scale, Isacks's group estimate local slopes by fitting planes to 400-by-400-m windows of data. Although reliance on data points spaced 100 m apart leads them to underestimate local relief, it nonetheless serves to provide an array of slope estimates across broad areas. When placed in a regional context, dramatic contrasts appear between the slope distribution for the regions of the foothill fold-and-thrust belts and those for the higher peaks, where slopes are about twice as steep (Fig. 2). Within these two domains, the majority of foothill slopes fall between 15–20° and occur where monsoonal intensity is highest, whereas in the higher mountains, average slopes exceed 30° and are associated with glaciated landscapes.

Isacks proposed that there are two "erosional buzzsaws": one associated with fluvial erosion in the foothills and the other with higher-altitude glaciation. If true, the repeated lowering of snowline in past glaciations might be invoked to explain the constant mean topography between the plateau and adjacent mountains. The efficacy of glaciers as erosional agents, however, is hotly debated: some people argue that they actually protect slopes from significant erosion. Clearly, glacial erosion changes the shape of valleys, but does it excavate them more rapidly than do rivers? Few data are available to address this.

Given that the Himalayan mountain building has been sustained for millions of years, it might be anticipated that a steady-state topography prevails, such that slope angles over the long term are stable and are controlled solely by local rock types acted upon by local surficial processes. It is possible, however, that elevated rates of erosion driven by glaciation and periglacial weathering have perturbed the equilibrium that commonly exists in areas where fluvial processes dominate. In its place, glaciers, large landslides and outburst floods may have moulded a landscape characterized by supercritical slopes and nonequilibrium topography.

Steeper slopes and deeper valleys, unloading the underlying mantle, could initiate isostatic uplift, as hypothesized by P. Molnar and P. England (*Nature* **346**, 29–34; 1990). Once again, DEMs may allow one to assess this hypothesis. Although no experimentally based models for glacial erosion or denudation by landsliding are presently available, volumes of eroded rocks within the mountains can be readily calculated using DEMs if prior topography is known or assumed. Restoring these eroded rock masses back into the mountains, as done by J. Masek (Cornell University) for the Himalayas, permits prediction of the isostatic deflection their removal would have caused. In a similar fashion, a natural experiment in Papua New Guinea — where a pristine early Pleistocene surface has been domed up to 4 km above sea level and partially dissected — has been used to assess the isostatic impact of erosion and to demonstrate that erosionally driven uplift here is relatively unimportant in comparison with tectonically driven uplift (L. Abbott and J. Galewski, University of California at Santa Cruz).

From the fruits of these initial studies, it is clear Earth scientists will have no trouble digesting whatever topographic data are sent their way. Part of the question now is persuading the various agencies compiling the databases (the US Department of Defense has the most extensive and detailed) to make them as widely available as possible. □

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DAEDALUS

Active rigidity

MOST engineering structures are limited not by lack of strength but by lack of stiffness. They fail not by breaking, but by bending or buckling. Some cars have 'active suspension' systems which sense and react against shocks and deformations. Daedalus now plans to extend this philosophy to hitherto passive engineering structures.

Imagine, he says, a thin hollow tube with a powerful laser beam shining straight up through the middle, without touching the sides. Suppose the tube begins to buckle out of true. The straight beam within it will graze the inside of the tube at the elbow of the bend. The material at that point will heat up and expand; the resulting restoring force will straighten the tube. In effect, the laser beam continuously scrutinizes the whole length of the tube, and counteracts perfectly every attempt at bending or buckling. The tube thus becomes infinitely rigid. It stands as straight and unbending as a beam of light.

The same effect might be achieved more neatly by evacuating the tube and firing an electron beam through it. Modern electron-optics can generate beams intense enough for welding, and highly parallel; furthermore, an anode at the far end of the tube could collect the beam as an electric current and recover its energy for recycling to the power supply. Either way, the massive conventional pillars, struts and girders of conventional engineering could be replaced by safe, narrow, actively rigid tubes. Elevated motorways could stalk the landscape on absurd-looking spindly legs; tower cranes could become as insubstantial as their cables, and street lamps could stand erect purely on their power leads.

More cunning still, actively rigid components could be reconfigured under central control. On an aircraft, for example, actively rigid wings would not only be far lighter than conventional ones, and far more rigid under changing aerodynamic loads; they could act as control surfaces too. Simply by shifting the aim of their internal lasers or bending their electron beams by a set of deflector coils, they could be precisely flexed or deformed to vary their lift and drag. In the same way, actively rigid swing bridges could open and close on demand, and actively rigid buildings under inertially-guided computer control could stand unmoved by the most violent earthquakes.

The downside of this elegant principle is that any actively rigid structure will collapse instantly if the power is shut off, even for a moment. A fast-reacting self-contained back-up power supply will be essential. On the other hand, scrapping or demolition will be simplicity itself.

David Jones