gence (Free Press, New York, 1994).
3. National Institutes of Health–Department of Energy Joint Working Group on the Ethical, Legal, and Social Implications of Human Genome Research (ELSI Working Group).

While not wanting to enter the debate about the merits, or lack thereof, of *The Bell Curve*, I have great difficulty with the assertion in the advisory group's statement that "Genetic arguments cannot and should not be used to determine or inform social policy in the areas cited . . . [and] [s]ince the lessons of genetics are not deterministic, they do not provide useful information on whether or not to pursue various [educational] programs. . . ." This assertion could logically be applied to all nondeterministic science, denying the validity of statistical inference, and rendering it useless for informing public policy. It may be, as argued by the advisory working group, that the scientific jury is still out on the role of genetics in human intelligence, or that the "lessons from genetics are misrepresented" in the book. However, as one of a host of researchers that have tried to apply the lessons of science to inform public policy, I cannot accept the argument that nondeterministic science cannot or should not, together with moral, social, and political considerations, inform public policy.

Roger A. Sedjo
Resources for the Future, 1616 P Street, NW, Washington, DC 20036, USA

■

Low-Angle Faults

Richard A. Kerr's account of the supposed disparity between observations and theory ("Geologists debate ancient life and fractured crust," Meeting Briefs, Research News, 24 Nov., p. 1300) calls to mind the fable of the blind men and the elephant. Gregory Davis is quoted as saying, "Our job as field geologists is to define and defend what we think we see [subhorizontal normal faults] and to let the theorists tell us how it can work." He may have hold of only the trunk of the elephant. A better objective is to understand the whole beast and how it works. On the theorists' side, Roger Buck says, "No one has ever come up with a viable explanation of how pristine rock could break at [an angle] lower than 45 degrees" during crustal extension. He may have hold of the elephant's ear.

If the debaters at the Geological Society of America meeting reported on by Kerr had considered seismic images of the deep crust (the feet of the elephant?), they would have seen that Earth's crust in these highly extended regions is full of subhorizontal reflections that indicate ductile shearing at low angles (*1*). Below a depth of about 12 kilometers, temperatures are high enough (greater than 350°C) to soften rocks and inhibit brittle earthquake fracture. Most of the faults under debate (excluding those that broke at a high angle and were later rotated to subhorizontal) began their complex histories in this deep realm and were later uplifted, denuded, and exposed at the surface.

Imagine a brittle rock layer floating on a soft sublayer, in the extreme, like ice on a pond. We have no difficulty in observation or theory with high-angle extensional faults in the brittle layer and an abrupt transition to basal shear below. The principal stresses are simply not maintained horizontal and vertical through the transition (*2*), and continuity requires that the bulk strain be nonhomogeneous. There is no contradiction in theory. Add the factor of geologic time, with magmatic heating (characteristic of the metamorphic core complexes where the low-angle faults are exposed) and continued tectonic extension. It is not strange that subhorizontal ductile shears formed at elevated temperatures are overprinted dur-

ing cooling by continued brittle deformation, nor that steep "breakaway" faults connect to the surface.

Of course, the elephant has other parts as well; the Earth, too, has striking contrasts in material properties, as well as complexities imposed by deformation evolving through time. But on the largest scale, deep reflection seismology supplies the connection between subhorizontal normal faulting and Coulomb-theory steep normal faulting.

George A. Thompson
Department of Geophysics,
Stanford University,
Stanford, CA 94305–2215, USA
E-mail: thompson@pangea.stanford.edu

References

1. J. McCarthy and G. A. Thompson, *Geol. Soc. Am. Bull.* **100**, 1361 (1988).
2. T. Parsons and G. A. Thompson, *Geology* **21**, 247 (1993).

■

The Science Doctorate

I take exception to the sentiment expressed by respondents on the subject of employment opportunities for those with science Ph.D.'s (Letters, 8 Dec., p. 1553). Those writers suggest that the commitment to attainment of the doctoral degree ought to be motivated by "sheer love of research" rather than considerations of career. Such advice may have been appropriate for a relatively small number of 19th-century gentlemen of leisure, but it is disturbingly out of touch at the end of the 20th century. Among recent doctoral students in science whom I have known, not one could have afforded the investment of time and the attendant retardation or permanent attenuation of income and net worth demanded by their programs were these not potentially offset by improved employment opportunities believed to be available to holders of the doctorate.

Richard W. Kerrigan
Director of Research, Sylvan America,
West Hills Industrial Park,
Kittanning, PA 16201, USA

In reading the letters concerning Ph.D. employment, I was struck by a recurring theme—that the attainment of scientific education be the goal in and of itself—and that for the best and brightest students future employment should be a secondary consideration. There is a flaw in this argument, however. While one can obtain an art degree and continue to paint in the attic, or attend a conservatory and then play in a community orchestra, it is not possible to earn a Ph.D. and then set up a molecular biology laboratory in the garage while flipping hamburgers to earn a living. A scientist in this day and age can only enjoy his or her chosen field by being employed in it. Because of this, and because of the time taken out of one's most productive years to attend graduate school, the scientific community has an obligation not to overproduce Ph.D.'s.

Charlotte E. Hotchkiss
Department of Comparative Medicine,
Bowman Gray School of Medicine,
Wake Forest University,
Winston-Salem, NC 27157–1040, USA

Stagnating budgets for the National Institutes of Health and the National Science Foundation have caused these agencies to turn down large numbers of otherwise fundable grant proposals, which has led to a reluctance of universities to hire postdocs to tenure-track positions. This, in turn, has led to a surge in the number of underemployed Ph.D.'s. The root of the problem, therefore, appears to be the unwise reduction of science budgets by the U.S. government. The increasing number of noncitizen postdocs, the appearance of perennial postdocs, and the sudden focus on alternative employ-