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- LETTERS

Seismic Hazard at the New Madrid Seismic Zone

In their report "Slow deformation and lower seismic hazard at the New Madrid seismic zone" (23 Apr., p. 619), Andrew Newman *et al.* analyze a regional network of Global Positioning System (GPS) velocity vectors in terms of a model developed for "infinitely long" strike-slip faults like the San Andreas, in the central United States (1). The apertures of the geodetic networks along the San Andreas are small with respect to the length of the fault, and far-field velocities approach the rate of relative plate motion. The exact opposite is the case in the study by Newman *et al.* The segmented fault system in New Madrid seismic zone is smaller than the scale of their regional geodetic network, and because the fault system they are studying is located within a stable continental interior, far-field velocities must approach zero (or extremely small values).

For these reasons, my colleagues and I made a detailed study in 1991 (2) of crustal strain with the use of a dense concentration of geodetic stations located astride a single major fault. Our repeated GPS measurements of this network in 1993 and 1997 appear to indicate lower rates of strain accumulation than we originally reported (2) on the basis of combined GPS and triangulation measurements. Lower rates of strain, however, do not necessarily imply lower seismic hazard for the region. It is quite possible that the strain energy released in the "storm" of large earthquakes that have been occurring in this area for the past few thousand years took hundreds of thousands, or even millions, of years to accumulate. If this is the case, a slow rate of strain accumulation over the past 6 years does not imply low seismic hazard.

The persistently high rate of seismic activity in the New Madrid Seismic Zone over the past few thousand years implies high seismic hazard in the foreseeable future.

To communicate any other message to the public would seem to be a mistake.

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Response

Our report examined two arguments widely cited to support assertions of high seismic hazard in the New Madrid zone, as illustrated by the National Seismic Hazard maps showing a higher hazard there than that shown for California. We found that both arguments seem incorrect.

First, our GPS measurements showed little or no far-field motion across the seismic zone, both near the fault and at distant sites. In contrast, Liu *et al.* (1) studied a network within ours, reported rapid strain accumulation comparable to that for the San Andreas fault, and interpreted this as consistent with an earthquake of magnitude 8 on the Richter scale occurring about once every 1000 years. Our observation of little or no resolvable motion, which Zoback and others now also find in their network, is independent of assumptions about fault mechanics. Both we and Liu *et al.* relate the inferred slip to earthquake recurrence through the standard steady-state assumptions criticized by Zoback. Although one might postulate alternatives, including time–dependent effects, the present data seem inadequate to require any explanation beyond that of little present motion.

Second, we revaluated an analysis by Johnston and Nava (2), which yielded a 550–to 1100–year recurrence for earthquakes with a magnitude greater than 8.3. We found that these data in fact correspond to a 14,000 +/– 7000 year recurrence for such earthquakes, or a 1,400 +/– 600 recurrence for magnitude 7 earthquakes. It thus appears that the largest **New Madrid** earthquakes are either smaller or less frequent than previously assumed. In our preferred model, these earthquakes are magnitude 7 (10 times smaller than one of magnitude 8). Similar proposals are being advanced by others based on fault lengths and geologic estimates of fault slip, both of which appear too small for magnitude 8 earthquakes. These observations have implications for seismic hazard estimates in the area. The predicted hazard depends on assumptions, many of which have considerable uncertainty because we have little seismological data from any but small earthquakes. For example, treating a magnitude 7 earthquake as one of magnitude 8 overpredicts the peak ground acceleration by a factor of two or more. Other factors contributing to the high values in the hazard maps include a model predicting higher ground motions than those estimated by alternative models, and parametrization of the largest earthquakes as occuring on widely separated faults, which increases the area of highest predicted hazard.

Thus, given what we are now learning, to avoid investigating and reassessing the assumption of high seismic hazard at the **New Madrid** seismic zone would seem a mistake.

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