EMERGING RESEARCH FRONTS - 2009

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Paul Spudich & Jon B. Fletcher talk with *ScienceWatch.com* and answer a few questions about this month's Emerging Research Front Paper in the field of Geosciences.

Article: Observation and prediction of dynamic ground strains, tilts, and torsions caused by the M-w 6.0 2004 Parkfield, California, earthquake and aftershocks, derived from UPSAR array observations
Authors: Spudich, P;Fletcher, JB
Journal: BULL SEISMOL SOC AMER, 98 (4): 1898-1914, AUG 2008
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SW: Why do you think your paper is highly cited?

Our paper has been highly cited because we published some unique observations of earthquake-induced ground rotations just ahead of a wave of interest in the subject caused by the recent development of inexpensive rotation sensors.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

The paper analyzes an unusually good data set. We observed ground rotations about 9 km from a M 6.0 earthquake on the San Andreas fault. There are few prior recordings of ground rotations in large, nearby earthquakes, and those few were recorded on smaller numbers of seismographs and analyzed using simplified methods. Our data allowed us to quantify rotations well and to discover that some aspects of rotation behave in the way predicted by simple plane-wave theory.

SW: Would you summarize the significance of your paper in layman's terms?

During earthquakes the ground not only shakes from side-to-side (S waves) or up and down (P waves), but also rotates (tilts and twists). Seismologists have many recordings of the side-to-side and up-down motions during quakes, but our observations are among the few and best recordings of the tilting and twisting of the ground. A better understanding of ground rotations might enable engineers to design buildings that are more earthquake-resistant.

How did you become involved in this research and were any particular problems encountered along the way?

In 1988 we deployed a dense seismograph array near the San Andreas fault in Parkfield, California, to catch an earthquake predicted to occur in 1988 +/- five years. At the time we had no thought of measuring rotations. The biggest problem that we encountered was that the expected quake occurred 16 years behind schedule, in 2004, requiring us to keep the instrumentation alive much, much longer than we had bargained for.

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While we were impatiently waiting, we recorded a distant large quake in 1992 that triggered other earthquakes throughout California but not in Parkfield.

To try to figure out why nothing was triggered at Parkfield, we developed a method to infer ground strains from our data for the 1992 quake. As an afterthought, we used our method to calculate its rotations as well as strains, both published in a 1995 paper.

Ironically, we were so uninterested in the rotations that the word "rotation" did not even appear in the title or abstract of that paper, nor of another which we published in 2006. But other readers spotted and used our method, suddenly making us "experts" on rotation, so we soon realized that our observations of the 2004 quake rotations would find an eager audience.

Where do you see your research leading in the future?

For us personally, it is difficult to say. Unfortunately, our agreement with the landowner of the array site, a very patient and helpful man who put up with us for 12 years longer than expected, required us to remove the instrumentation in 2005, so without a data source our next step is not clear. And even if we were to deploy a new array somewhere, we could wait a very long time for an equally good data set.

Do you foresee any social or political implications for your research?

Rotations of the ground can significantly affect the dynamic behavior of buildings, but currently buildings are designed without considering the effects of rotations because little is known about them.

Our observations of ground rotations give building designers a better understanding of the size of rotations during large earthquakes, which might change the way buildings are designed if rotations from seismic waves prove to contribute significant loads on buildings.

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