MEETING

Studying Geodesy and Earthquake Hazard in and Around the New Madrid Seismic Zone

Workshop on New Madrid Geodesy and the Challenges of Understanding Intraplate Earthquakes; Norwood, Massachusetts, 4 March 2011

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Twenty-six researchers gathered for a workshop sponsored by the U.S. Geological Survey (USGS) and FM Global to discuss geodesy in and around the New Madrid seismic zone (NMSZ) and its relation to earthquake hazards. The group addressed the challenge of reconciling current geodetic measurements, which show low present-day surface strain rates, with paleoseismic evidence of recent, relatively frequent, major earthquakes in the region. The workshop presentations and conclusions will be available in a forthcoming USGS open-file report (http://pubs.usgs.gov).

A fundamental observational constraint on intraplate strain is geodetic measurements of crustal deformation. Workshop participants noted that the relative motions between most of the 55 GPS station pairs in the NMSZ are less than approximately 0.2 millimeter per year. At best the uncertainties are of the order of 0.2 millimeter per year but are difficult to estimate reliably. Two baselines within the NMSZ show potentially significant relative motions of approximately 0.3–0.4 millimeter per year. Some workshop participants proposed that this reflects a physical process, while others suggested that it is the expected statistical behavior of a random distribution with zero mean.

Observations of stress and strength of the crust are important aspects of this problem. Workshop presentations showed that there is effectively no difference in the orientation of principal stresses in the NMSZ when compared to that of the surrounding region. Thus, the stress state in this region results from the same large-scale geologic processes stressing the central and eastern United States. Workshop attendees also noted that with respect to the stress field, slip on faults in the NMSZ is consistent with the faults' having high frictional strength, similar to faults throughout the region. Further, meeting presentations showed that limited available heat flow data do not show the NMSZ to be warmer (and thus weaker) than its surroundings.

Models that relate low long-term strain to the occurrence of earthquakes in the NMSZ include those that invoke crustal heterogeneity, glacial isostatic adjustment, erosion following retreat of the glaciers, and sinking of the Farallon plate. However, some participants noted that these processes may be responsible for triggering rather than sustaining repeated large earthquakes. Furthermore, observations of earthquake migration in China and models of stress evolution following the 1811–1812 earthquakes suggest that future earthquakes could occur on other faults in the region. However, scientists lack the ability to tell if and when these might occur.

Although there remains considerable uncertainty as to the ultimate driving force of these intraplate earthquakes, most participants agreed that it is reasonable to expect that processes responsible for strain accumulation prior to 1811–1812 are still active today. Overall, the attendees agreed that the current density of geodetic monitoring is inadequate to address the apparent discrepancy between models inferred from geodetic and geologic data. To improve models of intraplate strain, geodetic monitoring should be densified in key locations by a combination of continuous and less expensive, periodic campaign GPS deployments. In conjunction, new physically based models of intraplate seismogenesis and data that constrain intraplate earthquake generation and recurrence are needed.

The authors of this meeting report gratefully acknowledge feedback from attendees of the workshop and support from the remainder of the organizing committee: Eric Calais, John Langbein, Seth Stein, and Mark Zoback.

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