Can Hydration Reactions in the Lower Crust Act as a Source of Stress to Trigger Micro-earthquakes in Northeastern North America?

Alec McCormack[1], William Menke[2]
[1]Orange County Community College, [2] Lamont-Doherty Earth Observatory of Columbia University

The Northern Appalachian Anomaly (NAA) is a 200-km-deep region of upwelling mantle located beneath northeastern United States. Coinciding with this region is a high level of intraplate seismicity that occur in numerous clusters scattered within northeastern United States and southwestern Canada. Some of the clusters have sharp boundaries, with adjacent areas barren of activity. We hypothesize these patterns are due to the localized volumetric strain produced by hydration reactions in the lower crust, caused by fluids emitted by the NAA. These stressed modulate the background NE/SW-oriented plate tectonic stress pattern, bringing pre-existing faults closer to failure in some regions, and away from failure in other regions. A spatially smoothed map of observed epicenters is used as a proxy for earthquake probability, and its autocorrelation is used to summarize its spatial statistics. The location, dip, rotation, size, depth and intensity of multiple centers volumetric strain are input as sources in a 3D finite difference method of stress within a 300x300x40 km^3 area. The Coulomb Facture Criteria (CFC) due to these stresses is calculated for 30 degree dipping reverse faults with NW/SW-oriented P-axes (a direction consistent with many focal mechanisms in the region). Positive CFCs in the 0-10 km depth range are projected onto the Earth's surface and used as a proxy for earthquake probability. The spatial autocorrelation of the probability also is calculated. Maps of observed and predicted earthquake probability and spatial autocorrelations are compared. With several trials conducted, it is revealed that four-to-six 5x5x1 km^3 sources of volumetric strain in the deep crust can.