# Can Earthquakes be Induced by Thermal Expansion or Chemical Expansion Affecting Stress in the Earth?

*D. Fuentes[1], Dr. W. Menke[2]*

*[1]City College University, [2]Lamont-Doherty Earth Observatory of Columbia University*

The Coulomb Fracture Criterion (CFC) is used to assess whether or not earthquakes occurring in the shallow crust of New England (USA) might have a relationship to the Northern Appalachian Anomaly (NAA), a region of asthenospheric upwelling located directly beneath this region. We hypothesize that lower crustal volume changes are produced by chemical alteration (retrograde metamorphism) caused by heat and hot fluids from the NAA. These volume changes perturb the overall compressive stress regime due to plate tectonic loading, and move reverse faults either towards or away from failure. While metamorphic reactions locally can increase the volume by tens of percent, we assume that the peak volume increase in the altered region is only 1%, corresponding to about 2% of the whole rock reacting. A suite of different shapes of the altered regions, all with a volume of 5 $km^3$ and centered at 30 km depth, are simulated using a 3D finite difference method. CFC's were calculated for a suite of coefficients of friction and fault dip angles. In all cases, reverse faulting was suppressed in a 5-10 km diameter zone in the shallow crust centered directly above the altered region, with the CFC being reduced by up to 3 Mpa. This suppression is due to the increased normal stress. Shallow crustal reverse faults were driven towards failure in a 10-20 km doughnut-shaped zone surrounding the suppressed zone, with the magnitude of the CFC depending strongly om the shape of the altered region. The strongest effect (by up to 3 Mpa) is predicted for a chimney-shaped altered region, and in this case the doughnut has two intense patches, parallel to the axis of plate tectonic loading. The overall effect of the chemical alteration is to lead to pattern of seismicity that is spatially very heterogeneous and that shares some similarity with the actual pattern of seismicity observed in New England.