Mineral, VA Earthquake Demonstrates the Passive Aggressive Margin of Eastern North America

Frank Pazzaglia

Intra-plate earthquakes, like the recent M 5.8 Louisa County, VA earthquake of 23 August, 2011, are sobering reminders of how little we know about the lithosphere and active tectonics of plate interiors, including passive continental margins. The arrival of the TA to the east coast and Appalachians in 2013 has inspired several EarthScope projects, many of which share a common goal of describing lithospheric structure and heterogeneities in the context of repeated geologic assembly and rifting of the margin, active tectonics, dynamic topography, surface processes, and associated natural hazards. These studies locally densify the TA with various FA networks, complement it with a nascent network of PBO-quality GPS geodetic receivers, and can be coordinated with rift initiation and evolution GeoPRISMS projects being conducted offshore. Collectively, observables from these studies are well-poised to test two different articulated visions for dynamic support of the entire margin and the role it might be playing in driving active tectonics. As an example, results from an EarthScope RAPID project focusing on the Virginia earthquake are provided. Historic seismicity in eastern North America (ENAM) displays a pattern of seismic clustering, such as the central Virginia seismic zone (CVSZ), interspersed with regions of less or no active seismicity. Two possibilities emerge as plausible explanations. One is that lithospheric- or crustal-scale structures focus intra-plate stresses at locations where they are regularly released. If the seismicity of such regions is persistent, resulting from a plate-scale stresses acting on legacy lithospheric and crustal-scale structures, it should give rise to geodetic and geomorphic deformation observables. The alternative is that our window of observation is so short that the clusters emerge from long-lived aftershocks following large earthquakes, like the 1886, M ~7.3 Charleston event that can occur anywhere throughout ENAM with no attendant focused, long-term cumulative surface deformation. The location of the recent Virginia earthquake is consistent with resolvable surface deformation expressed in offset geomorphic markers and river channel patters. The reverse fault that ruptured in the earthquake is responsible for cumulatively uplifting the eastern Virginia piedmont ~6-10 meters relative to its western footwall since the middle Pleistocene. To our knowledge, this is the first and only clear demonstration of crustal and surface deformation directly linked to observed seismicity anywhere in ENAM. It therefore serves as a surface deformation field constraint of geodynamic models for persistent intraplate earthquake generation and their associated hazards in a passive margin setting.