Propagation of P- and S- waves and the variation of peak amplitude from earthquake's epicenter using the Mississippi 2012 earthquake as a case study

Author: Oluwaseun Fadugba

Persistent link: http://hdl.handle.net/2345/3847

This work is posted on eScholarship@BC, Boston College University Libraries.

2014

This work is licensed under a Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/).
The Mississippi 2012 earthquake occurred in the northern Gulf of Mexico at 4:24:13 AM on November 10, 2012. The earthquake’s epicenter (source) was located at 30.1˚N, 88.1˚W with a moment magnitude of 2.6. Seismic stations operated by the EarthScope transportable array project were operating near the source of this earthquake in 2012 and detected the earthquake at different arrival times as it propagated through the USA. This project uses these seismic data to visualize the propagation pattern and characteristics of earthquake using spatial analysis technique in GIS.

Because amplitude decreases below the background noise at seismic stations further from the epicenter, only 100 of the 502 stations operating at this time detected the earthquake. Waveforms were retrieved from an IRIS data management center and were processed using a 2-10 Hz bandpass filter. P- and S-wave arrival times and peak amplitude were manually selected and visualized in Esri ArcGIS using the Spatial Analyst tool (Fig. 1). These waveform data were then superimposed on a geologic map to study their propagation characteristics with respect to bedrock lithology.

Earthquakes are modeled in geophysics as a dispersion of energy from an epicenter that propagates outward in concentric circular pattern. Also, peak amplitude decreases with the square of propagation distance away from the source. The P- and S-wave maps created in this project (see figures 2 and 3, respectively) verified this theoretical model of concentric energy propagation from the earthquake’s source. The concentric characteristic was only apparent in areas with the same rock types and changed where geology becomes complex. The propagation showed a ‘flow’ pattern as it passed through different rock types with different competence. Peak amplitude also decreased with propagation distance from source but decreased faster in more competent rocks and slower in less competent rocks (Fig. 4). The variation in peak amplitude of the Mississippi 2012 earthquake showed waveform properties such as diffraction, reflection and interference.

The Spatial Analyst tool proved effective in the visualization of propagation of seismic waves through rocks. The propagation of P- and S-waves, and the variation of peak amplitude were distorted by the Mississippi embayment and the southern Appalachians. In contrast to the theoretical model of energy dispersion, the actual pattern of energy propagation remained somewhat concentric in rocks with same lithology but was distorted at the boundary with different rock units. This peak amplitude propagation is analogous to a ripple pattern caused by dropping a stone into a still pool.

**Abstract**

**Propagating Waves and the Variation of Peak Amplitude from Earthquake’s Epicenter Using the Mississippi 2012 Earthquake as a Case Study**

**Source of Data:** IRIS DATA MANAGEMENT CENTER and NATIONALATLASS.GOV

502 seismic stations were operating at the origin time of the Mississippi earthquake and their waveforms were retrieved from the IRIS data management center using the IRIS.fetch algorithm in MATLAB. The waveforms were filtered using a 2-10 Hz butterworth to remove unwanted frequencies. Because amplitude went below the background noise at stations further from the epicenter, only 100 seismic stations detected the earthquake. P- and S-wave arrival time and the peak amplitude of the waveform were picked manually from these 100 waveforms.

The Spatial Analyst tool embedded in Esri ArcGIS was used to display all stations. Maps of P- and S-wave travel times were also made using ArcMap. The peak amplitude map for the earthquake was made to appreciate how energy decreases with distance away from the epicenter.

**Source:** OLUWASEUN FADUGBA
DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES, BOSTON COLLEGE

**Figure (2):** Seismic waveform from the Mississippi 2012 earthquake detected at AL US-BRAL station in Alabama.

**Figure (3):** Propagation of S-waves from the Mississippi 2012 earthquake. The pattern is distorted by the Mississippi Embayment (surrounded by red dashed circle) and the southern Appalachians (surrounded by the black dashed circle).

**Figure (4):** Variation of peak amplitude due to dissipation of energy as seismic waves propagate from the epicenter. The pattern is distorted by the Mississippi Embayment (surrounded by red dashed circle) and the southern Appalachians (surrounded by the black dashed circle).