Jamaican Seismology
with reference to other islands in the Greater Antilles

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Jamaica
Contents

- Historical earthquakes
- Tectonic setting
- Recent significant earthquakes
- Current seismicity
- Research and development
- Future outlook
The Earthquake Unit

- operate the Jamaica Seismograph Network (JSN) [12 stations, 8 accelerographs]
- maintain a database of all earthquakes recorded by the JSN
- inform the public about recent earthquakes
- collect information about effects of earthquakes felt in Jamaica
- conduct research on the seismicity, seismic hazard, site response and vibration analyses & related fields
- Exchange data with international and regional networks
- Jamaica’s National Data Centre of the Comprehensive (Nuclear) Test-Ban Treaty Organization’s (CTBTO) International Data Centre
- Welcome visits from school & community groups
# Global frequency of occurrence of earthquakes

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Occurrence on average per year</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 8</td>
<td>1</td>
<td>Great</td>
</tr>
<tr>
<td>7-7.9</td>
<td>17</td>
<td>Major</td>
</tr>
<tr>
<td>6-6.9</td>
<td>134</td>
<td>Strong</td>
</tr>
<tr>
<td>5-5.9</td>
<td>1,319</td>
<td>Moderate</td>
</tr>
<tr>
<td>4-4.9</td>
<td>Est. 13,000</td>
<td>Light</td>
</tr>
<tr>
<td>3-3.9</td>
<td>Est. 130,000</td>
<td>Minor</td>
</tr>
<tr>
<td>2-2.9</td>
<td>Est. 1,300,000</td>
<td>Very minor</td>
</tr>
</tbody>
</table>
### Historical Earthquakes

#### Eastern Jamaica
- 1692 (X)
- 1771 (VII)
- 1812 (VIII)
- 1907 (IX)
- 1914 (VII)
- 1993 (VII)

#### Western Jamaica
- 1839 (VII)
- 1943 (VII)
- 1957 (VIII)
1692 Port Royal, Jamaica
1946 DR earthquake
## Average Frequency of Earthquakes

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Return Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>1.1</td>
</tr>
<tr>
<td>5.0</td>
<td>8.7</td>
</tr>
<tr>
<td>5.4</td>
<td>20.0</td>
</tr>
<tr>
<td>6.0</td>
<td>70.0</td>
</tr>
<tr>
<td>7.0</td>
<td>611.0</td>
</tr>
</tbody>
</table>
Jamaican earthquakes per century

<table>
<thead>
<tr>
<th>Intensity</th>
<th>1600-1699</th>
<th>1700-1799</th>
<th>1800-1899</th>
<th>1900-1999</th>
<th>2000-2999</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>8</td>
<td>88</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>6</td>
<td>53</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>VI</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>VII</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>VIII</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IX</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>X</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Number of events:
- 1600-1699: 1
- 1700-1799: 11
- 1800-1899: 100
- 1900-1999: 200
- 2000-2999: 10

Intensities: III, IV, V, VI, VII, VIII, IX, X
Fault types

Strike-slip

Normal

Reverse
Tectonic setting
Jamaican seismicity

NJF  North Jamaica
WFZ  Walton
DFZ  Duanvale
RMCR Rio Minho-Crawle River
MNB  Montpelier-Newmarket
WWB  Wagwater
YPG  Yallahs-Plantain Garden
SCr  Santa Cruz
ST  Spur Tree
SoC  South Coast
BM  Blue Mountain

December 5-6, 2005  MDWG-ISE/CD
Stress orientations in the Jamaican crust
Aenon Town, Central Jamaica
June 12, 2005, M 5.1

Legend

- 2.0
- 2.0 - 2.4
- 2.4 - 3.0
- 3.0 - 3.5
- 3.5 - 5.1
- +/- 1.8 km Error Buffer

Map of Jamaica

SOURCE MECHANISM

NORTHWESTERN FAULT

Epicentre Locations with Error Buffers
June 12 Damage - Toppled Cockpit summit - Frazier, SW St. Ann

December 5-6, 2005

MDWG-ISE/CD
House Damage – June 12 - Lemon Walk, Trelawny; Top Alston, Clarendon; Grant’s Bailey, St. Ann
Cayman EQ, Dec 14, 2004, M 6.8
PGA – PAIGH
(Shepherd et al., 1999)
Site classes - Kingston
www.oas.org/CDMP/hazmap.htm/kma.htm
Alluvial Plain dynamics

Amplification is variable across the plain depending on the location of the source and the position within the plain.

Large amplifications over wide range of frequencies expected at the margins of the plain from nearby earthquake sources.

Shift to lower frequency response as basin deepens to the south.
Amplitude attenuation observed in coda waves

\[ A(f, t) = t^{-\beta} A_0 e^{-\pi f \kappa} e^{-\frac{\pi ft}{Q(f)}} \]

- Near-surface attenuation
- Geometrical spreading
- Whole-path intrinsic attenuation
Q(f) for Jamaica compared with other places
Attenuation – Ca vs Ja
Summary

• The northern Caribbean plate boundary deforms by left-lateral strike-slip

• The slip rates are relatively slow 18-20 mm/yr implying long return periods of potentially devastating earthquakes

• Microplates are forming in response to blocking of the westward drift of the Caribbean plate in the north-eastern corner by the Bahamas Platform

• Constructing local spectral attenuation relation is a necessary prelude to constructing proper spectral hazard maps.
THE END
## TSUNAMIS IN JAMAICA (Lander et al., 2002)

1 in 160 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Event Description</th>
<th>Tsunami Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1688</td>
<td>Mar-01</td>
<td>Earthquakes felt</td>
<td>a ship at sea damaged by hurricane not hurricane season; No report of tsunami reaching the shore</td>
</tr>
<tr>
<td>1692</td>
<td>Jun-07</td>
<td>Earthquake MMI X estimated magnitude 7.5</td>
<td>Port Royal sank - 2000 killed in the harbour sea withdrew 274m, 1.8m wave, sea withdrew 1.6 km at Yallahs?</td>
</tr>
<tr>
<td>1812</td>
<td>Nov-11</td>
<td>Earthquake</td>
<td>Sea agitated, sea floor subsided at Annotto Bay causing a ship to lose it anchor no report of tsunami reaching the shore</td>
</tr>
<tr>
<td>1852</td>
<td>Jul-17</td>
<td>no earthquake reported</td>
<td>ship 113 km from Jamaica affected by turbulent sea simultaneous with agitation in harbour at Santiago de Cuba no report of tsunami reaching the shore</td>
</tr>
<tr>
<td>1907</td>
<td>Jan-14</td>
<td>Earthquake MMI IX estimated M 6.5</td>
<td>Kingston earthquake - 1000 killed, seiches of 2.5m in Kingston harbour, waves up to 2.5 m affected the north coast from Buff Bay to St. Anns Bay, sea receded up to 93 m at Annotto Bay, 69m at Ocho Rios</td>
</tr>
</tbody>
</table>
# Tsunamis in Hispaniola (Lander et al., 2002); 1 in 25 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Event</th>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1751</td>
<td>Sep-Nov?</td>
<td>Earthquake Ms 8.0</td>
<td>destroyed Port au Prince and caused subsidence off the coast</td>
<td>no tsunami reported</td>
</tr>
<tr>
<td>1770</td>
<td>Jun-03</td>
<td>Earthquake Ms 8.0</td>
<td>200 fatalities at Port-au-Prince</td>
<td>waves noted at the Gulf of Gonave and Arcahaie, 7.2 km inland inundated</td>
</tr>
<tr>
<td>1775</td>
<td>Feb/Mar</td>
<td>Earthquake Ms 8.0</td>
<td>Leveled storehouses</td>
<td>much damage by waves also in Cuba</td>
</tr>
<tr>
<td>1842</td>
<td>May-07</td>
<td>Earthquake Ms 8.0</td>
<td>4,000 - 5,000 killed</td>
<td>destructive tsunami on the north coast, sea receded 60 m, waves 5m killed 300 of 3,000, at St. John wave height 3.1m, at Santo Domingo 2m</td>
</tr>
<tr>
<td>1860</td>
<td>Mar-08</td>
<td>Earthquake Ms 8.0</td>
<td>felt at Port-au-Prince and Anse-a-Veau</td>
<td>waves noted at the Gulf of Gonave and other places</td>
</tr>
<tr>
<td>1887</td>
<td>Sep-23</td>
<td>Earthquake Ms 8.0</td>
<td>felt at Port-de-Paix, Inagua &amp; Jamaica</td>
<td>at Jeremie, sea withdrew 20m and returned with a rush</td>
</tr>
<tr>
<td>1916</td>
<td>Aug</td>
<td>no earthquake</td>
<td></td>
<td>powerful waves in Santo Domingo harbour wrecked an 18,000-lb. ship, waves &gt;15 m high</td>
</tr>
<tr>
<td>1918</td>
<td>Oct-11</td>
<td>Earthquake M7.5 in Mona Passage</td>
<td>sub-marine cables cut</td>
<td>at Santa Domingo water in Rio Ozama fall and rose 70 cm every 40 minutes - 140 killed in tsunami</td>
</tr>
<tr>
<td>1946</td>
<td>Aug-04</td>
<td>Earthquake M 8.1</td>
<td>devastated the Dominican Republic and Haiti</td>
<td>Matancitas destroyed by 2.5m tsunami, at Julia Molina 4-5m, killed 100? waves at San Juan 36 mins later, damage on west coast PR, reached Bermuda 2hrs 7 mins later, also reached Daytona Beach and Atlantic City</td>
</tr>
</tbody>
</table>