

VIBRATORY GROUND MOTION  
FROM A DISTANT LARGE MAGNITUDE EARTHQUAKE  
A DISCUSSION OF THE 1755 LISBON EARTHQUAKE

by  
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SYNOPSIS

Large magnitude earthquakes (Richter Magnitude > 8.5) are characteristically different from medium or low magnitude earthquakes. Even at large epicentral distances they cause significant damage, but this damage, unlike low magnitude nearby earthquakes, is associated with low frequency, long duration and low amplitude peak ground motions. This note discusses the example of the large magnitude 1755 Lisbon Earthquake which occurred offshore along the Azores-Gibraltar Fault.

The Great Lisbon Earthquake of November 1, 1755, as discussed by Richter (1958) is one of the greatest earthquakes known to have occurred during the period of recorded history. Machado (1966) estimates that this earthquake was of Magnitude 9.0, at coordinates 36.4N-11.2W, along the Azores-Gibraltar Fault, which forms the plate boundary between the Eurasian and African plates in the offshore regions southwest of the Iberian Peninsula. Recently discovered unpublished manuscripts from 1004 Spanish cities and villages which were compiled by the Academia de la Historia of Spain immediately after the occurrence of the earthquake have been analyzed by the authors, and these data have been compiled with existing published data to prepare a detailed isoseismal map of this event for the entire Iberian Peninsula (Fig 1).

Local geologic conditions were an important factor in determining the ground motion experienced for different areas far away from the epicenter. For example, villages located throughout the valley of the Guadalquivir River, over deep alluvium, experienced damage equivalent to or greater than a Modified Mercalli Intensity VII, while villages in the Sistema Central, about the same distance from the epicenter, but bearing on competent rock, experienced less damage. From a detailed review of historical damage accounts, ground motions from the earthquake have been interpreted to be of low acceleration and long duration, with a marked attenuation of high frequency motion away from the epicenter. Historical manuscripts indicate that the earthquake's strong, low frequency motions lasted several minutes throughout the Iberian Peninsula.

It is emphasized that the study also clearly indicates that the Modified Mercalli Intensity scale may not properly account for motion associated with this type of event, as the predominantly low frequency and long duration may cause damage to tall, well built structures before damage is experienced in low buildings although they may be poorly constructed. An example of the unusual effects of low frequency ground motions occurred in La Coruña, Spain, about 800 kilometers from the epicenter, where some tall chimneys toppled, but many people on the ground did not feel the earthquake.

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FIGURE 1 - ISOSEISMAL MAP OF THE  
NOVEMBER 1, 1755 LISBON EARTHQUAKE  
FOR THE IBERIAN PENINSULA

