

# 2 February 1816, an Overlooked North Atlantic M 8 Earthquake

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## Abstract

The 2 February 1816 North Atlantic earthquake is virtually unknown to the international scientific community, and the few existing studies—solely based on two or three macroseismic intensities—pointed to a magnitude near 7 and a location at the eastern end of the Gloria fault in the Azores-Gibraltar Fracture Zone (AGFZ). Through careful search, we discovered more than 40 independent macroseismic observations and were able to estimate a total of 26 values of intensity, covering a wide geographical area (Iberian Peninsula, Madeira, and Azores). To apply the Bakun and Wentworth (B&W) method to the macroseismic dataset, we also deduced intensity–distance attenuation equations for the three different Atlantic coasts. The B&W procedure enabled us to conclude that the 2 February 1816 earthquake had a moment magnitude of  $8.6 \pm 0.3$  at the 95% confidence level and an epicentral location of  $37.8^\circ$  N and  $19.8^\circ$  W, near the central part of the Gloria fault. These results place the event as the greatest known earthquake in the Gloria fault domain and as one of the greatest ever seismic events along the AGFZ, probably only surpassed by the 1755 Lisbon earthquake.

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[Supplemental Material](#)

## Introduction

Since the advent of instrumental seismology, three events of  $M_w \approx 8$  have occurred along (Fig. 1) the Azores-Gibraltar Fracture Zone (AGFZ): the 25 November 1941  $M_w$  8.25 Gloria fault, the 28 February 1969  $M_w$  7.8 Gorringer Bank, and the 26 May 1975  $M_w$  7.8 North Atlantic earthquakes (Bondár *et al.*, 2015; Di Giacomo *et al.*, 2015; Baptista *et al.*, 2016; International Seismological Centre [ISC], 2020). In contrast, global historical catalogs only document two similarly great earthquakes taking place in the same geographical region, both in the eighteenth century. One is the renowned 1 November 1755 Lisbon earthquake (Stucchi *et al.*, 2013); the other is the much less notorious 31 March 1761 earthquake (Baptista *et al.*, 2006). Although their locations and magnitudes are still under debate (see, for instance, Fonseca, 2020), most studies put both in the eastern half of the AGFZ and attribute, namely to the first, a magnitude substantially larger than any of the aforementioned twentieth century events (Fig. 1).

Inevitably, one may wonder if the absence of great earthquakes between 1761 and 1941 is a true gap or is due to the incompleteness of present historical catalogs. Furthermore, a recent study of Hough (2013) suggested that about half of the  $M_w \geq 8.5$  nineteenth century earthquakes are still missing or underestimated. The purpose of this work, thus, is to characterize one of these possible events, the 2 February 1816 earthquake, and assign it reliable values of epicenter coordinates and magnitude.

## Searching for Data

This earthquake was first studied by the Portuguese naturalist Franzini (1818), who reported observations from Lisbon (mostly taken from the daily newspaper *Gazeta de Lisboa*) and from two Portuguese ships—*Paquete de Lisboa* and *Marquez de Angeja*—in the Atlantic Ocean, at distances of 600 and 1400 km from Lisbon, respectively—revealing that it had stirred the sea in Zwolle (Netherlands), more than 1900 km away from the Portuguese capital. In Lisbon, according to Franzini, the earthquake was strong, took place at 0.40 a.m. (local time), lasted for almost 1 min, with vibrations from northeast to southwest, and caused generalized scare among the residents, many of whom fled from their houses, fearing a repetition. Indeed, a very weak and brief aftershock did happen at 6.45 a.m. He also stated—without providing details—that the mainshock was felt throughout the entire country.

Franzini's study was republished in the *Annales* of Gay-Lussac *et Arago* (1819), together with information that the earthquake was also felt in the Portuguese Madeira island (Funchal?). The same data was later reproduced in the catalogs of Perrey (1847) and Mallet (1854) and in the regional catalogs of Galbis Rodríguez (1932) and Oliveira (1986), among others.

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