

The 15 October 2013 Magnitude 7.2 BOHOL EARTHQUAKE

On 15 October 2013, a **very destructive earthquake** (8:12 am local time) shook Bohol Island and the entire Visayas Region, causing significant damage to houses, buildings and infrastructures: It had a magnitude of 7.2, focal depth of 12 km and its epicenter was plotted near the boundary of the municipalities of Sagbayan and Catigbian in Bohol (6 km S24°W of Sagbayan; 7 km East of Catigbian and 34 km N45°E of Tagbilaran City). As of 30 November 2013, at least 3,900 aftershocks were recorded, of which more than 100 were reported felt. This earthquake was generated by the **North Bohol Fault (NBF)**.

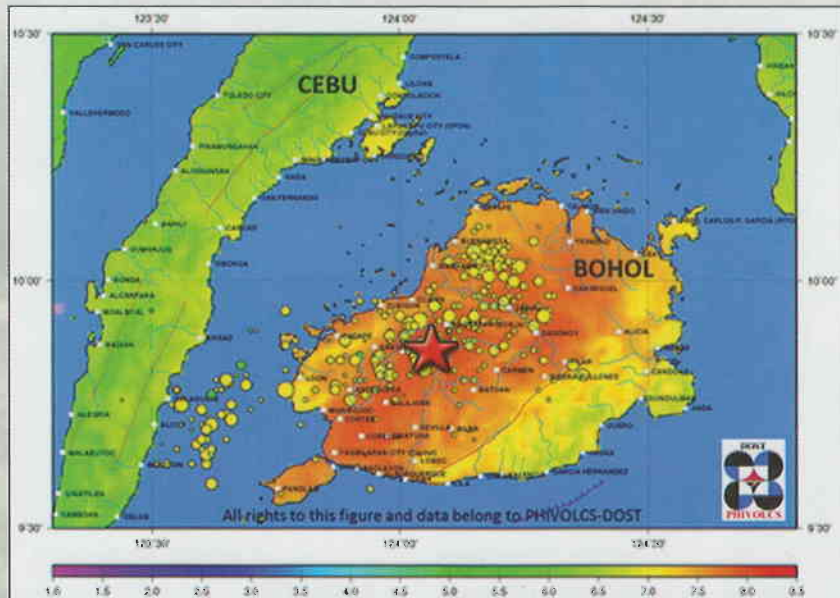
The earthquake was associated with surface rupture and produced strong ground shaking, liquefaction and earthquake-induced landslides. Because of the ground shaking several sinkholes appeared after the earthquake. Severe damage to houses and infrastructures, including century-old heritage churches, was observed. There were more than 200 deaths and 600,000 affected families. The estimated cost of damage to public infrastructures amounted to at least two billion Philippine pesos or 50 million US dollars.



Aerial view of the surface rupture of the North Bohol Fault (NBF) in Brgy. Anonang, Inabanga, Bohol



2.5-meter fault scarp in Brgy. Anonang, Inabanga, Bohol



The epicenter (red star) of the 15 October 2013 Magnitude (M_w) 7.2 Bohol Earthquake and preliminary plottings of its aftershocks (yellow circles) (PHIVOLCS weblist Oct. 15 - Nov. 3, 2013). Colors show intensities (in PEIS) simulated using the Rapid Earthquake Damage Assessment Software (REDAS) and fault orientation from the initial PHIVOLCS-JICA-JST SWIFT focal mechanism. Red lines in Cebu and Bohol are active faults.



Collapsed frontage of a century-old church in Loay, Bohol



Rock fall that damaged a house in Brgy. Poblacion, Boljoon, Cebu

Why do earthquakes occur in Bohol?

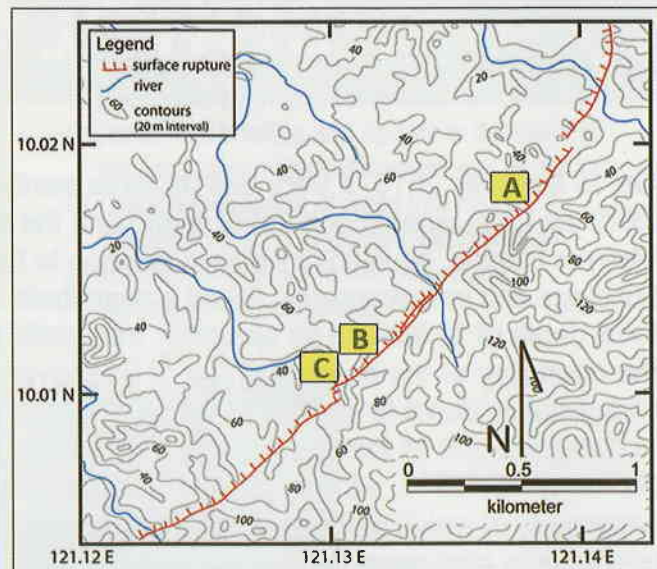
Bohol Island is one of the seismically active areas in the country. Instrumental monitoring of earthquakes for the past century has detected many small to moderate magnitude earthquakes in the island. On 08 February 1990, a magnitude 6.8 earthquake occurred in Bohol. This was generated by a reverse fault located offshore, southeast of the island. During this earthquake, 16 municipalities felt the strongest intensity of ground shaking at PHIVOLCS Earthquake Intensity Scale (PEIS) VIII. There were reports of severe property damage, six fatalities, more than 200 injured and several thousands rendered homeless. The municipalities of Jagna, Duero, Guindulman, Garcia Hernandez, and Valencia experienced tsunami inundation. Another earthquake generator in the island is the East Bohol Fault. Active faults in nearby islands like Negros, Cebu and Leyte can also be sources of earthquakes which may be felt in Bohol. Other earthquake generators in the island would be local offshore faults and nearby trenches.

The surface fault rupture of the 2013 Bohol Earthquake

The NBF, a NNE-SSW trending reverse fault which had no previous surface manifestation, generated this earthquake. It is characterized by a six-kilometer-long surface rupture in its northern extent, and about one-meter-high uplifted recent marine terrace in its southern extent.

The longest, continuous surface rupture mapped is at least two kilometers in Brgy. Anonang, Inabanga. In this area, the fault generally trends N40E and dips 50SE. It is mostly manifested by scarps with vertical displacements ranging from two to five meters. The fault vertically displaced Cawasan Creek by 2.5 m, producing a small waterfall. Wide deformation zone extending to about 50 m was also measured.

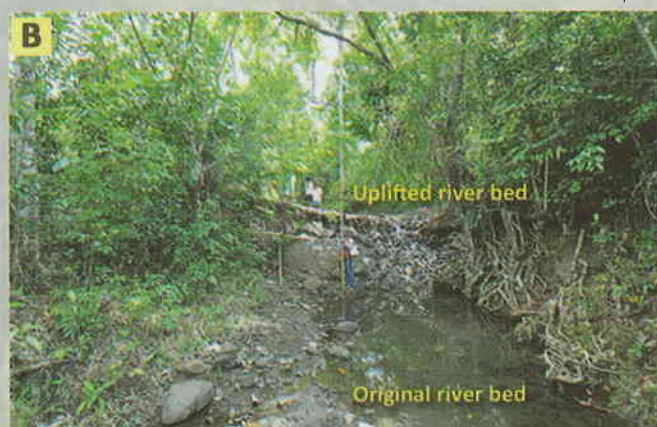
The uplifted marine terraces in the municipalities of Maribojoc and Loon are a good geomorphic evidence of reverse faulting and would probably indicate the southwest extension of the NBF in western Bohol. This is manifested by one-meter vertical displacement which shifted the shoreline of Punta Cruz, Maribojoc by about 50 m towards the sea.



Surface rupture map in Brgy. Anonang, Inabanga, Bohol. Letters indicate the location of the photos shown below.



A continuous fault scarp of the North Bohol Fault in Brgy. Anonang, Inabanga, Bohol



Vertically-displaced riverbed (~2.5 m) of Cawasan Creek in Sitio Calubian, Brgy. Anonang, Inabanga, Bohol



A series of gentle flexures resulting to an approximately 50-m wide deformation zone in Sitio Calubian, Brgy. Anonang, Inabanga, Bohol



An observed recent marine terrace uplift. (left) aerial view of uplifted marine terrace in Loon, Bohol; (right) 50-meter-coastal emergence in Punta Cruz, Maribojoc, Bohol

Other Earthquake Hazards

Damage due to **ground shaking** was widespread affecting the north- and south-western municipalities of Bohol, namely, Maribojoc, Loon, Tubigon, Calape, Clarin, Inabanga, Buenavista, Sagbayan, Catigbian, San Isidro, Antequerra, Balilihan, and Cortes. These towns felt the strongest ground shaking at PEIS VIII (very destructive ground shaking). It resulted to extensive damage and collapse of houses, buildings, bridges and other infrastructures. The damage was highlighted by the destruction of century-old heritage churches which had been part of the cultural identity for the people of Bohol. Structural damage was also reported in Tagbilaran City, in the southern municipalities of Bohol, including Loboc, Danao, Carmen, Lila, Valencia, Albuquerque, Baclayon, Loay, and in Metro Cebu. These areas felt the ground shaking at PEIS VII (destructive ground shaking). The rest of Cebu Island, neighboring islands of Negros, Camiguin, Panay, Leyte, Samar and several areas in southern Luzon and Mindanao felt the earthquake at varying intensities of PEIS VI-I.



Damaged two-storey house with first floor pressed under the second floor in Maribojoc, Bohol



Severely-damaged Sagbayan Municipal Hall due to strong ground shaking



Landslide in Loon, Bohol



Sinkhole near a school compound in Pangangan Island, Calape, Bohol



Collapsed church in Clarin, Bohol

Widespread **liquefaction**, as shown by lateral spreading, fissuring, subsidence, rise of buoyant objects and sandboils, were observed in areas near rivers and along coasts.

Mass wasting, manifested by landslides, rock falls and slumping, were also documented. Some of the landslides resulted to damming of rivers, which may cause flash-floods downstream. Incipient landslides, characterized by widespread tension cracks, were observed in hilly and mountainous areas.

Since Bohol Island is generally underlain by limestone and calcareous sediments sinkholes, as large as 70 meters, were observed and documented in many areas.



Extensive lateral spreading near the river banks of Napo River, Inabanga, Bohol



Sandboils (gray) in a cornfield in Brgy. Cauayan, Inabanga, Bohol

Information, Education and Communication (IEC) Activities and other Stakeholder Engagements

Immediately after a strong earthquake, affected communities need right information. PHIVOLCS immediately released earthquake information to the public and dispatched Quick Response Teams (QRT) to conduct damage assessment and information dissemination campaigns to allay the fears of the people in Bohol and Cebu Islands.

Briefing



PHIVOLCS Director Renato Solidum, Jr. provides earthquake update during the briefing with President Benigno Aquino III, Chairman of the NDRRMC, and Secretaries of DSWD and DOST right after the event



PHIVOLCS briefing with Bohol Governor Edgar Chatto and the PDRRMC

Quick assessment

PHIVOLCS conducted impact assessment on areas where potential landslides, flashfloods and sinkhole collapse may occur, as requested by LGUs and residents. Pre-emptive evacuation and relocation of some of these communities were recommended.



Assessment of relocation site in Brgy. Basac, Loon, Bohol with Disaster Aid International volunteer

Information Dissemination



QRT informs and advises residents of Brgy. Poblacion, Boljoon, Cebu about incipient landslides and rock falls in their area



IEC at the evacuation area in Brgy. Anonang, Inabanga, Bohol



Children in Brgy. Guiwanon, Maribojoc learn about the PHIVOLCS Earthquake Intensity Scale



Municipal-wide IEC in Inabanga, Bohol



Landslide assessment in Brgy. Bagacay, Loon, Bohol

What to expect?

- ☐ Based on historical and instrumental seismicity, large magnitude earthquake along the NBF may possibly occur hundreds of years from now.
- ☐ Earthquakes may still affect Bohol Island due to presence of other earthquake generators in the region.



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