

Cariaco: 30 years after the Caracas earthquake

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In the city of Caracas, about 400 km far from the epicentre, the tall buildings of Los Palos Grandes and Altamira, situated on very thick sedimentary deposits, swayed during several seconds. The «Ciudad de México» effect was once again felt.

It was in 1530 when Cumaná was shaken by a strong earthquake. But at that time the frail human memory was not blindly trusted, and the events were put down in writing, thus inaugurating South America's fertile seismic catalogue. Numerous seismic movements in the northern band of the country have been recorded since that time and, when in 1997, the 30th anniversary of the 1967 Caracas earthquake was being remembered, Cariaco was again to make an appearance in the seismic records.

Earthquake details

The North-east of Venezuela was shaken by an earthquake with a magnitude of Ms 6.8 at 15: 24 local time (19: 24 GMT) on Wednesday July 9, 1997, its hypocenter was at a depth of 10 km, it lasted some 10 seconds and was related to the great El Pilar fault. Its epicenter (10.54 °N, 63.51 °W) was placed between Cariaco and Casanay on the peninsula of Araya, some 70 km to the East of Cumaná, the capital of the state of Sucre. Damage was caused in an

area with a radius of 70 km around the epicenter, and there were 73 deaths, 531 injuries and 5,000 more were affected.

Up to 350 aftershocks were recorded per day in the weeks following the main earthquake; these always had depths lower than 19 km and were located along a band 5 km to the South and 20 km to the North of the El Pilar fault. At the end of July the number of aftershocks each day fell to around 50.

The earthquake was felt in the states of Sucre, Anzoátegui, Monagas, Nueva Esparta, Miranda and even in the city of Caracas, about 400 km far from the epicentre, where the tall buildings of Los Palos Grandes and Altamira, situated on very thick sedimentary deposits, swayed during several seconds. The «Ciudad de México» effect was once again felt: a amplification of the vibration at a large distance from the epicenter, in tall buildings situated where the soft subsoil is very thick.

Geotectonic context

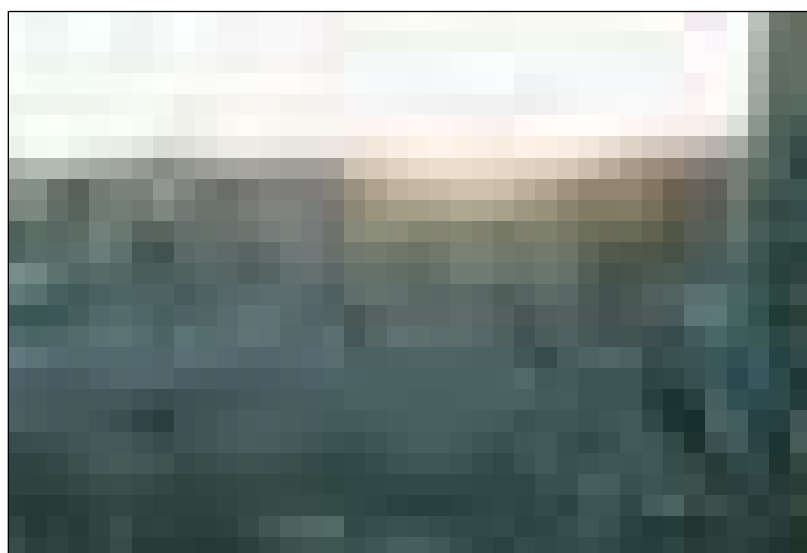
In Venezuela, the contact area of the South American and Caribbean plates runs along the northern border of the country from the state of Tachira, on the frontier with Colombia, to the state of Delta, where the Orinoco flows out, passing through the city of Caracas. This system of faults is called Boconó-San Sebastián-El Pilar, and is where the horizontal movement between both plates takes place at a rate of between 2 and 3 cm per year.

Seismic history

The strongest earthquake known to the area occurred in 1766, and had a Ms magnitude in the order of 7.9, causing damage in Caracas - situated 300 km from the epicenter - and was felt as far away as Maracaibo, 800 km away. Other large earthquakes occurred in 1543, 1766, 1794, 1797, 1805, 1839, 1853 and 1929.

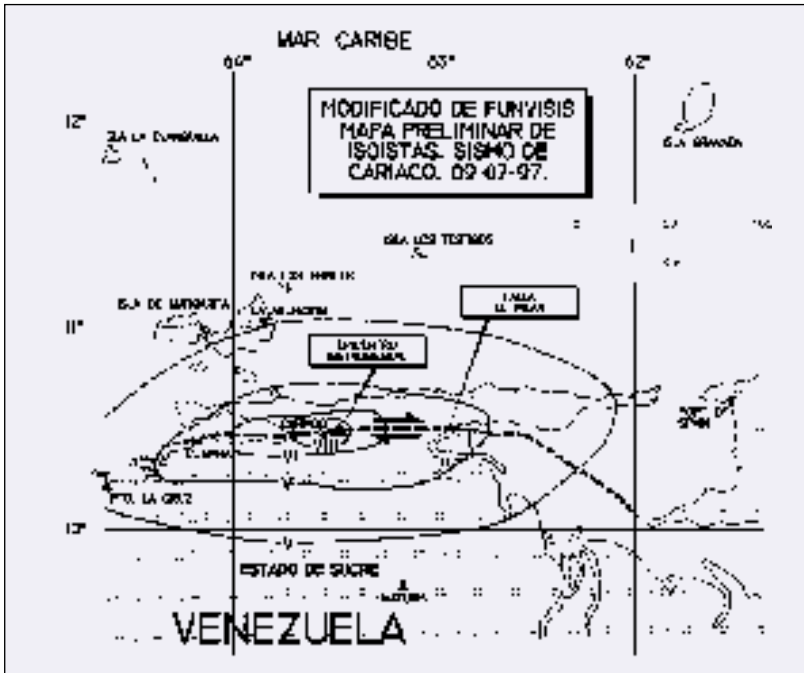
Isoseismal and attenuation map

After the Cariaco earthquake, FUNVISIS* depicted a preliminary isoseismal map with information obtained from 300 intensity questionnaires which were sent to the af-



Miramar building-Cumaná. Headquarters of La Seguridad insurance company. The asymmetrical stiffness distribution is showed in the standing shear walls that surrounded the stairwell and elevator shaft (left side of the building). Photo: ITSEMAP Venezuela.

* This article was written using information obtained from the local press and reports produced by the teams of scientists from FUNVISIS (Fundación Venezolana de Investigaciones Sismológicas) and ITSEMAP Venezuela, who visited the area of the disaster.



Preliminary isoseismal map (MMI) of the earthquake of July 9, 1997, Ms=6.8 according to FUNVISIS.

ected areas. The area of maximum VIII intensity was restricted to an elongated narrow area between Cariaco and Chinguana. In general terms, the isoseismals show a clear E-W tendency, in accordance with the morphology of the valley which reveals the presence of the El Pilar fault. A rapid attenuation of the seismic energy is also observed, mainly in the N-S direction (see map).

Effects

The most surprising effect of the Cariaco earthquake was a surface rupture of the land of a length of at least 30 Km, and an average displacement of some 25 cm between Muelle de Cariaco and Las Varas. There was no visible vertical component and the rupture reached up to 3 or 4 meters in width. This rupture crossed some roads in the area and made some sections unusable due to landslides, collapses, and in some cases, due to a liquefaction effect or loss of strength of water-saturated sediment. The geological effects of the earthquake were however concentrated along the coast and in sparse locations in the interior. Liquefaction, collapses and landslides occurred mainly on reclaimed land, river or channel banks and the coast. Some small earth dams used in the irrigation of

small family plots, slid rotationally due to liquefaction.

With respect to material damage, Cumaná, a city of 350,000 inhabitants, witnessed the collapse of a building, taking with it the life of 21 people. The Miramar building, centrally located on Avenida Perimetral, was a 6 stories structure built in 1979, with large interior openings in the first two stories. The building was constructed of reinforced concrete with rectangular section beams and without transversal reinforcement at the beam-column joints of the structure. Only the section surrounding the stair and elevator shaft on the first two floors remained standing; proof of the asymmetry in the stiffness of the building (see photo). Two floors of the Miramar building were acquired by the insurance company La Seguridad in 1986.

Another three buildings in Cumaná suffered serious structural damage apart from the Miramar building. The central hospital de Cumaná suffered a preventive evacuation, but after a professional inspection, it was revealed that only received slight non-structural damage.

In Cariaco, at less than 10 km from the epicenter, and only a few hundred meters from the rupture of the surface, two schools collapsed, burying 30 schoolchildren. In the

Valentín Valiente School, a building of two floors with a symmetrical rectangular shape, faults were detected in the design of the structure. Short columns were created when large spaces were opened for windows on the ground floor.

Also in Cariaco, the Raimundo Martínez school was a four stories building with a reinforced concrete structure that was constructed in 1989. The school was apparently composed of two units with a C plan shape each, and separated by a few centimeters. The ground floor collapsed in both buildings. The main causes seem to be the massive presence of short columns together with a lack of lateral reinforcement of the joints of the structure.

The collapse of the roof of an open air parking lot used for vehicles imported for sale occurred in Margarita. There was also considerable damage caused to the undersea cable which supplied electrical energy to Nueva Esparta.

With reference to utilities, the surface rupture of the ground and its posterior movement interrupted the supply of water and electricity to many towns in the affected area, especially in Cariaco.

The Superintendencia de Seguros (the insurance regulator) in Venezuela does not at the present time have total figures for the impact of the Cariaco earthquake on the local insurance market. Considering the low penetration of insurance in the area, it is to be foreseen that the economic impact on the sector will not be very high.

Lessons

Local experts have considered the Cariaco earthquake to be the most important seismic event since the earthquake in Caracas in 1967. In addition to the damage already mentioned, damage was also caused to many bahareque homes (mud and cane), and it will surely be a traumatic experience for the economy of the area. In addition to this, the collapse of the recently constructed office buildings and schools deserves a more careful analysis. A warning lesson for a country in which large earthquakes have occurred every 30 years on average during this century. Too short a time to forget, but long enough to prevent.