Earthquake Reports

Costa Rica Earthquake

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On Sunday, March 25, 1990 Costa Rica was hit by two earthquakes of moderate magnitude which caused slight damage in San José and near the epicentral region on the Pacific coast. The events occurred at 07:16 a.m. and 07:23 a.m., local time. The epicenters of both events nearly coincide and were located in the ocean, south of the Nicoya Peninsula, 19 km southeast of the small town of Cobano.

Seismoligists at the Universidad Nacional, Heredia (UNA) describe the earthquakes' origin as being of the subduction type between the Coco and the Caribbean Plates, where the dip is about 25-28°. However, at the Universidad de Costa Rica (UCR), it is believed that the seismic events occurred in a fault system within the Caribbean Plate.

Some discrepancies exist about the magnitude of both events. At Boulder, Colorado the magnitudes were determined to be M_S=5.5 for the first event and M_S=6.9 for the second one. Thus the main event compares in magnitude with the December 1988 Armenia Earthquake. These are mean values obtained from 40 stations worldwide (A. Espinosa, USGS, Boulder, Colorado, personal communication). Nevertheless, the magnitudes given by the Instituto de Geofisica in Panama were MD=5.2 and MD=6.5 (CODA) for these events.

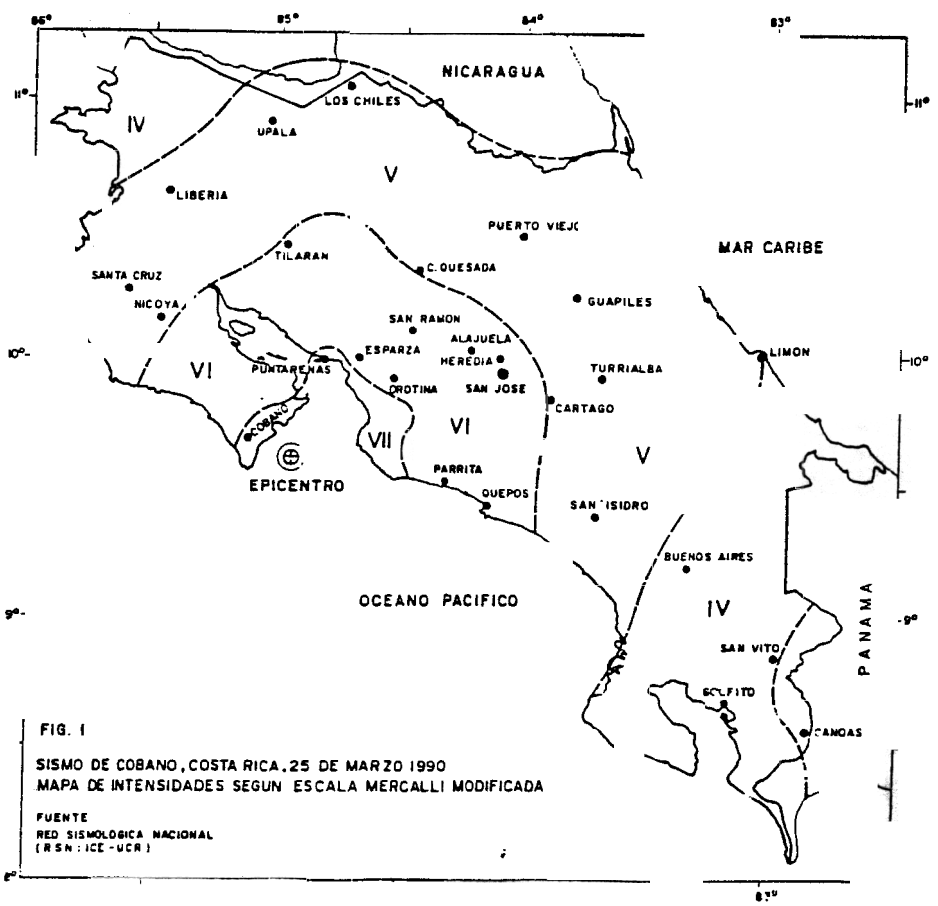

FIG. 1

SISMO DE COBANO, COSTA RICA, 25 DE MARZO 1990
MAPA DE INTENSIDADES SEGUN ESCALA MERCALLI MODIFICADA

FUENTE
RED SISMOLOGICA NACIONAL
(RSN: ICE-UCR)

The earthquakes were preceded by foreshocks the day before (an MD-3.4 event at 03:42 p.m., on March 24) and were followed by an impressive number of low magnitude aftershocks (exceeding 2000), which continued for several days after the main events.

In San José, the capital city of Costa Rica, no significant structural failure was reported. The observed damage was limited to cracking of masonry walls, broken glass windows and fallen parapets in buildings and churches. An observation trip to the Pacific Coast near the epicentral area, including Puntarenas, a city of 40,000 inhabitants located 30 km east of the epicenter, revealed sporadic damage and two structural collapses. Low income houses suffered collapse or heavy damage, but the number does not exceed 100.

Two cases of liquefaction phenomena were reported on the Pacific coast (in Puntarenas and near Rio Tulin, south of Jaco Beach). Few small earthslides were observed on the roads linking Orotina with Jaco Beach and San José with Limón. Electric power disruption in some regions of the country lasted about 3 hours and the telephone system was saturated by the large number of phone calls, but was not disrupted by building damage or equipment failure.

According to the data obtained from UCR, the Modified Mercalli intensity was estimated below MMI VI in San José and the central region of the country and MMI VII in the coastal plain of

the Pacific Ocean near the epicenter.

Records from strong-motion instruments have not been processed at the present time. The Instituto de Investigaciones en Ingenieria (IINI), at the UCR has given preliminary data regarding the peak accelerations obtained. They are summarized in Table 1. The data obtained from the accelerograph network in the country will provide valuable information about this earthquake.

No deaths were reported and 15 people suffered light injuries from broken window glass and brick fragments. The damage caused by these earthquakes can be considered as very low and the economical losses are estimated to be less than two million dollars, a figure which does not relate to the magnitude of the earthquake.

The reason for the discrepancies between the magnitude estimates and the low intensities cannot be explained satisfactorily at this moment. The focal mechanism, focal depth and energy radiation pattern will have influenced the intensities. Good construction practice in Costa Rica, where adobe and bahareque type construction were banned eighty years ago after the destructive 1910 Cartago earthquake, implemented by an up-to-date seismic code, may account also for the low damage observed.

Only one case of considerable non-structural damage in an engineered structure was observed. The Monseñor Sanabria Hospital in Puntarenas, a 9-story reinforced concrete building with a T-shape in plan, was undergoing seismic retrofitting and strengthening. It suffered cracking and damage to "non-structural" hollow brick masonry walls. No structural damage was observed. The seismic retrofitting of the hospital, which included reinforced concrete shear walls, was complete up to the 9th floor on the west side of the building, was only partially finished up to the 2nd floor on the east side and up to the 5th floor on the north side. Torsional effects, and the brittle material used for the inner partition walls (hollow clay masonry), account for the intense secondary damage observed.

Reported damage to the Municipal Building in Puntarenas, turned out to be only soil settlement around the building. The 4-story cantilevered structure showed excellent seismic behaviour with no structural damage observed.

Permanent lateral displacement at the base of an unanchored fuel storage tank was reported in Barranca, near Puntarenas. The "elephant's foot" phenomenon was formed in the tank wall.

The authors wish to thank the following institutions for some of the data presented in this report: Instituto de Investigaciones en Ingenieria (IINI), Red Sismológica Nacional ICE-UCR, Observatorio Vulcanológico y Sismológico (UNA), and Comisión Nacional de Emergencias (CNE). Personal gratitude is given to Dr. Eng. Guillermo Santana B. (IINI & CNE) and Marino Protti (UNA) for their collaboration in sharing the earthquake data available.

Table 1. Preliminary data on peak accelerations obtained from the March 25, 1990 Cóbano Costa Rican Earthquake. (Source: IINI, UCR)

Location	Peak accelns (%g) Horizontal		Vert.
Hospital Monseñor Sanabria Puntarenas, 1st Floor	25.5,	26.5	13.7
Centro Regional UCR San Ramón, 1st Floor	9.8,	9.2	8.2
Edificio CIPET Alajuela, 1st Floor	14.7,	16.6	5.1
Clinica CCSS Hatillo, 1st Floor	9.7,	8.8	5.7
Edificio Central ICE La Sabana, 1st Floor	6.9,	9.4	3.7
Hotel Aurola Holiday Inn San José, Basement	6.8,	6.3	3.7
17th Floor	7.0,	13.4	12.1
Edificio de Geologia, UCR San José, free-field	5.4,	7.5	4.4
Edificio Central INS San José, Basement	6.5,	8.3	4.5

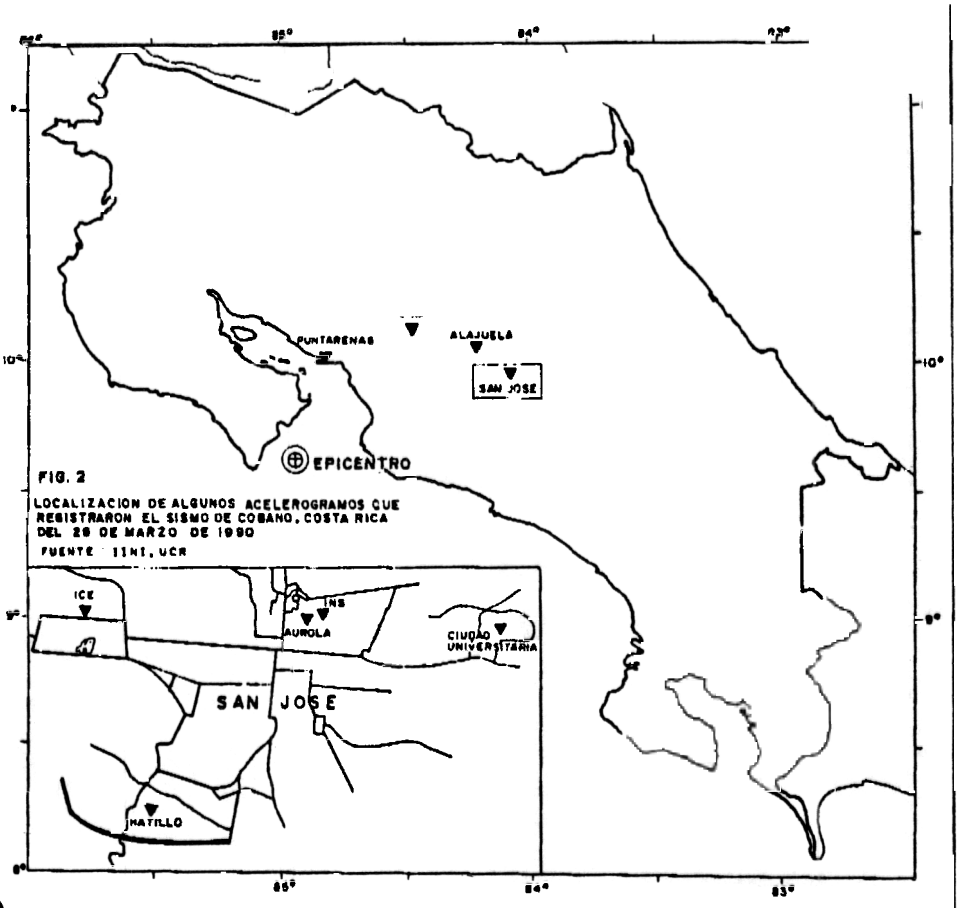

FIG. 2
LOCALIZACION DE ALGUNOS ACELEROGRAMOS QUE REGISTRARON EL SISMO DE COBANO, COSTA RICA DEL 29 DE MARZO DE 1990
FUENTE : IINI, UCR

Event	Latitude	Longitude	Depth (km)
1st	9° 35.34' N	84° 57.78' W	28.7
2nd	9° 36.71' N	84° 56.02' W	29.7

Note: Dr. Guillermo Santana (IINI) has more data on the accelerograph readings, and is taking steps to have them digitized and processed.

Newcastle Earthquake

NEWCASTLE EARTHQUAKE, 27 DECEMBER 1989 (GMT)
--Cynthia Perry, Dames & Moore, San Francisco

SEISMOLOGY

Earthquakes on the Australian continent are caused by compressive stresses which have built up in the crust as a result of the northerly movement of the Australasian Plate under the Indonesian Plate. Although intraplate seismicity is still not well understood, it appears that most stable-continent earthquakes occur within crust that has undergone extension at some time in the past, producing failed rifts and passive margins. Rifts are formed when the brittle upper crust breaks into blocks under the influence of extensional forces. If the extension stops, what remains is a failed rift within the interior of a continent. If the extension continues, the rift will eventually rupture, leaving weakened crust along the edges of the resultant continents. These areas with weakened crust have ancient faults, buried under a blanket of sedimentary material, which may lie dormant for many millions of years (Reference 1). There is a passive margin all along the eastern seaboard of Australia, where Newcastle is located. In the United States, New Madrid, Missouri is located over a failed rift and Charleston, South Carolina is located along a passive coastal margin.

The first reported earthquake in Australia was at Port Jackson, Sydney in 1778. Although there have been numerous earthquakes since then, the Newcastle Earthquake in 1989 was the first Australian earthquake to cause fatalities and significant structural damage. Earthquakes having Richter magnitudes M(L) greater than 4.0 during the period 1873-1983 are shown in Figure 1. Two previous earthquakes in the Newcastle area, one in December 1925, the other in 1868, had magnitudes M(L) of 5.2 and roughly 5.3, respectively (Reference 2).

REGIONAL GEOLOGY

The city of Newcastle is located at the mouth of the Hunter River, near the boundary of two geological regions - the Sydney Basin and the New England Fold Belt. Newcastle lies at the northern edge of the Sydney Basin, characterized by Permian sediments which include alternate marine and continental sequences bearing numerous coal seams. The New England Fold Belt, to the north, contains rocks of various ages which are all moderately to heavily folded. These two regions are separated by the Hunter Thrust System, including several small faults which lie to the northwest of Newcastle near Maitland.

Coal mining is an important feature of the economic geology