

# STAR QUEST

## Earthquakes



A. Original position of the fault.



B. Deformation of the fault.



C. Rupture of the fault.

### How an earthquake is produced.

million dollars.

An earthquake is a series of vibrations produced in the Earth's crust. It is caused by the sudden abrupt release of slowly accumulating energy along a fault, a surface or zone of fracturing within the Earth. The vibrations can range from barely noticeable to catastrophically destructive. Six kinds of shock waves are generated in the process: two are classified as body waves, that is, they travel through the Earth's interior, and the other four are surface waves. Waves occur when two parts of the Earth's outer lithosphere slide past, away from, or into



Seismometer at Mona Island Seismic Station

This Friday, October 11, marks the 78th anniversary of the 1918 earthquake that devastated the city of Mayaguez. Located about nine miles to the northwest of Aguadilla in the Mona Passage, that quake registered a 7.5 magnitude on the Richter scale and generated 20-foot waves. In Mayaguez and many west-coast towns, buildings swiveled, split open, or collapsed, and huge piles of rubble lined the streets for some time. Landslides scarred the western mountains and foothills. Flooding from a tsunami destroyed additional homes, roads, and bridges, and more than 100 people lost their lives. Damage was estimated at four

each other. According to current theory, the Earth's surface is made up of many large thick slabs called tectonic plates, which ride like giant rafts on semi-fluid rock below. Geologists believe that the plates are driven by large convection currents created by heat generated deep within the Earth by radioactive decay of certain elements. Over the years, the Earth's lithosphere has been split up and put together many times, leaving millions of scars or faults. Many of these old faults are static, but every so often stresses build up because of rock movement in the mantle, causing a fault to rupture and an earthquake to occur.

Today, geologists use two different scales to measure how strong an earthquake is. The Richter scale measures the actual size or amplitude of the wave generated by a particular earthquake on a seismograph. This is an indirect measure of the amount of energy released by the earthquake. It is a logarithmic scale that runs from one to nine in magnitude. A one point increase on the Richter scale equals a tenfold amplitude of wave increase, which equals approximately 32 times more earthquake energy. A second type of scale is the Mercalli intensity scale, measured in Roman numerals, that measures the amount and type of damage that earthquakes do to buildings and other structures, and their effects on humans.

Three kinds of earthquakes are now recognized -- tectonic, volcanic, and artificially produced. The tectonic variety is by far the most devastating. Most tectonic quakes occur at the boundaries of the tectonic plates, in zones where one plate slides past another. Volcanic quakes are of interest mainly because they often indicate impending volcanic eruptions. Humans can induce earthquakes through activities such as the filling of new reservoirs or the underground detonation of atomic explosives.

Puerto Rico is the easternmost island of the Greater

Antilles. Located in the boundary zone between the North American and Caribbean plates, it is the focus of frequent seismic activity. Five principal areas of seismicity have been identified. To the north, the Puerto Rico Trench is a major tectonic feature associated with the subduction ("diving") of the North American Plate under the Caribbean Plate. To the south, the Muertos Trough is a linear feature of active underthrusting of the Caribbean Plate, with low seismic activity. To the east, the Anegada Trough is an active tectonic feature that has had large historic earthquakes. To the west, the Mona Canyon and Mona Passage separating Puerto Rico from Hispaniola is a complex region of very active seismicity. Within Puerto Rico itself, two major fault systems cut through the island, the northern and southern Puerto Rico Fault Zones.



Puerto Rico is located in the boundary zone between the North American and Caribbean Plates.

All these trenches, troughs and faults produce some 800 tremors a year in the Puerto Rico region. The Puerto Rico Seismic Network, ascribed to the University of Puerto Rico Mayaguez Campus, is responsible for recording all seismic activity in Puerto Rico. The network consists of 14 seismometers, or stations, installed in Puerto Rico and on nearby islands, that constantly record data about the tremors that occur. A weight suspended by springs inside each seismometer creates a small electrical current as it vibrates. An amplifier strengthens the signal, and a radio transmitter powered by solar panels beams the information to the central receiving station, now located in Cayey but soon to be moved to a new center at the Mayaguez campus. If at least three stations report a tremor at the same time, a computer starts recording data from all over the network until the earthquake is over. With this information scientists determine the location and strength of the earthquake.

Unfortunately, what scientists cannot determine is when or where an earthquake will occur. "People have studied earthquake prediction for years, and then suddenly have said, 'Forget it,' laments Christa von Hillebrandt, Director of the Seismic Network (see Beacons). "The most frustrating thing is that I can study them, but I can't predict them, and I don't fore-



Electronic Technician giving maintenance to the station in Desecheo Island

see anybody being able to predict them for a long time." Puerto Rico has suffered four major damaging earthquakes in its history. The largest earthquake of this century occurred in 1943 in the Puerto Rico Trench northwest of the island and registered 7.75 on the Richter scale. It, however, was not as damaging to the island as the 1918 quake.

Scientists warn that a major damaging earthquake can occur at any time. Be prepared.

## BEACONS



**Christa G. von Hillebrandt-Andrade** is one of Puerto Rico's best-known earthquake watchers. As Director of the Puerto Rico Seismic Network at UPR Mayaguez Campus, she is often in the news, reporting monthly seismic counts or providing details about a noticeable quake.

Born in New Jersey, von Hillebrandt soon moved with her family to Puerto Rico and studied for 12 years at San Jose Academy in Guaynabo. She is fluent in three languages -- English, Spanish and German -- and she put this ability to use in her studies following high school. At the University of Delaware, with her junior year at the University of Heidelberg, she graduated Cum Laude with a B.Sc. in geology; and at the National Polytechnic School in Ecuador she received a Fulbright Scholarship to specialize in the study of volcanism.

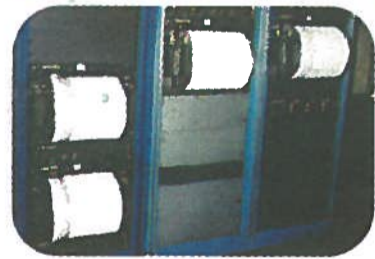
Von Hillebrandt worked with the Puerto Rico Department of Natural and Environmental Resources, the Geophysical Institute in Quito, and the Seismic Network as a laboratory technician before being named to her present position. She has participated in seminars and courses throughout this hemisphere, and she has published numerous volcanic maps and studies

# FACTOID

Up until July 30, 1996, 475 earthquakes have been registered at the Puerto Rico Seismic Network this year.

## The Adventure Continues

The Puerto Rico Seismic Network office is located in the Physics/Marine Science and Geology Building at the University of Puerto Rico Mayaguez Campus. As we enter the grounds of the building, we notice a vault resembling a small metal house. Inside the vault is a seismometer registering the different vibrations of the Earth and sending a signal to a heli-coder inside the network office, some 20 feet away.



Heli-coders where the seismic data from the stations are recorded.

The office itself has a Data Acquisition Room with three computers constantly receiving signals from the 14 stations that make up the network. Of these three, two are used for data acquisition, and the other registers the main tremors that show up on the first two. We examine the heli-coder, connected by a cable to the seismometer outside the building, that is registering on paper the data it receives. There are seven other heli-coders in the room. Seismic Network Director Christa von Hillebrandt explains that she and her staff

decide which stations will be connected to the heli-coders, and that all stations but those at Portugues and Cerrillo in Ponce are changed from time to time.



Building where the PR Seismic Network is located at the UPR-Mayaguez.



Puerto Rico Seismic Network Research technician analyzes the traces of an earthquake

The Seismic Network currently consists of four full-time employees -- the director, her administrative assistant, a research technician, and an electronic technician -- and about ten students from the university's engineering, physics and geology departments. Students can visit the office and watch a 3-D computer program showing all the local earthquakes that are registered. For more information, call the network at 833-8433/fax 265-1684. If you cannot visit the office personally, you can find the network on the World Wide Web:

Http://rmsismo.UPR.ciu.edu -- where the staff holds a Home Page with earthquake maps and other related information.