Earthquake

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2. Category: Earth Sciences (Earthquakes)

3. Brief Description:

Earthquake is a demonstration of how the epicenter of an earthquake is located and how its Richter Magnitude is determined.

Generally, an earthquake is a result of a sudden displacement of rocks within or just below the crust of the earth. Regardless of the causes, an earthquake is a set of vibrations that rapidly travels in all directions through the earth from some origin (the focus). These traveling vibrations are waves and are a means of energy transfer from one place to another. Earthquake waves (seismic waves) come in different forms and have different names. This exercise will concentrate on two types of seismic waves: the P (or Primary) wave and the S (or secondary) wave. Depending on the amount of energy released at the focus, seismic waves can travel thousands of kilometers. Wave velocities can vary with rock type, temperature and other factors, but P waves generally travel about 12-14 Km/sec and S waves about 3-5 Km/sec. Unlike the slower traveling and damage-causing surface (L) waves, P & S waves can only be detected by a sensitive instrument called a seismograph. The seismic wave chart record is called a seismogram. The Earthquake application simulates an earthquake occurring somewhere in California and the seismograms of this earthquake as they are recorded at three seismic stations: one at Eureka CA, another at Fallon NV, and a third at Las Vegas NV. From these three seismograms the user can determine the epicenter of the simulated earthquake (the point on the earth's surface vertically above the focus) and its Richter magnitude. The location of the epicenter will be determined using triangulation and the Richter magnitude will be estimated graphically from the seismogram amplitude and the distance from the recording station to the epicenter.

4. How the Application Can be Used:

Earthquake is an application designed for use in an introductory instructional laboratory for college students enrolled in a beginning geology course.

5. Developed under NeXTSTEP 0.8, 0.9, 1.0, 2.0 & 2.1

6. Detailed Instructions:

Launch the Earthquake application and study the main window for a moment before clicking the Earthquake button. The left side of the window contains a map of the western states which shows the location of a few major cities of the region. The right side of the window contains views in which seismic tracings will be displayed at three stations: Eureka, Fallon and Las Vegas. Go ahead and click the Earthquake button. Once seismic motion stops, study the seismic tracing. You should be able to recognize three distinct parts to each tracing. Looking from left to right there should be a straight line which represents no detected seismic motion. The initial displacement that occurs along the straight line moving from left to right marks the point in time at which the P wave arrived at the station in question. P-wave vibrations have small amplitudes. The point in time when these vibrations suddenly increase in amplitude is called the S-wave arrival time. Below is part of a seismogram that displays these three parts.

Because the P and S waves travel at different and approximately known velocities, it is possible to calculate the distance these waves have traveled simply by knowing the time interval separating their arrivals as a seismic station (S-P interval). This distance is called the epicentral distance. The user must measure the S-P interval by dragging the mouse pointer from the P arrival time to the S arrival time on the seismic tracing. Earthquake will calculate the epicentral distance. For Eureka the S-P interval should be about 32 seconds and the calculated epicentral distance should be about 356 Km. Go ahead and measure the S-P interval for Fallon NV and for Las Vegas NV.
The epicentral distance of 356 Km for Eureka means that somewhere on the perimeter of a circle with radius of 356 Km, centered at Eureka, the earthquake occurred.

In order to determine the epicenter of this earthquake the user must construct three circles: one around each of the recording stations with each having a radius equal to the epicentral distance for that station. These circles will intercept at a single point or close to a single point (provided the S-P intervals have been measured correctly.) You can "drag" out these circles using the mouse. The radius of each circle will appear in the field below the map. Note: After about 10 circle-drawing attempts, you will have to "clear" the display and start again by pressing the Earthquake button. Once you are successful at locating the epicenter, perform a mouse click on the epicenter. You should be rewarded.

The second aspect of Earthquake involves determining the Richter Magnitude which is a number that gives an estimation of the amount of energy released by the earthquake at the focus. The Richter Magnitude determination was devised by Dr CF Richter of Cal Tech in 1935 and uses the amplitude of the seismic tracing from the seismogram of a recording station. Click the "Show Richter Window" button and you will see a graphical device called a nomogram that will allow you to determine the Richter Magnitude. The number is based on the definition of a standard as established by Professor Richter: a magnitude 3 earthquake is one that is 100 Km away and produces 1 mm of amplitude of the S wave (vertical offset on the seismogram). Move the right vertical slider and determine the magnitude of an earthquake 100 Km away that produces 10 mm of amplitude, and then 100 mm of amlitude. Now determine the Richter magnitude of the earthquake of this exercise. Front the earthquake window vertically drag out the amplitude of the S wave for the Las Vegas tracing. (The vertical offset goes to the top and bottom of the seismogram window in this example.) Click the "Show Richter Window" button again and move both the sliders so that they correspond to the epicentral distance and amplitude for the recording at Las Vegas. The real amplitude of this quake was about 7.3. What did you get?

7. Comments: Enjoy!