Earthquake Location
CONEX Read-ahead

Introduction

The quick and accurate detection of an earthquake is important both for coordinating emergency response, and for monitoring fault lines. In the United States, the National Earthquake Information Center processes data from a global seismograph network to quickly determine the location and magnitude of an earthquake. Similar centers exists around the world. In this set of problems we will consider the two main types of seismic waves that travel through the earth, and see how these can be used to pinpoint the epicenter of an earthquake.

Figure 1: Toppled buildings in Taiwan (1999)

Figure 2: Road damage.

Instructions

After reading through *Earthquake Location* context and questions below, you should complete the reflection assignment in Canvas. Note: *you will have a chance to talk further with your coach before answering the questions below in detail.* The point of this read-ahead and the reflection is to "prime the pump" for further conversations with your coaches.

Earthquake Location

Primary waves (P-waves) are compressional waves that are longitudinal in nature. P-waves travel faster than other waves through the earth to arrive at seismograph stations first, hence the name "Primary". These waves can travel through any type of material, including fluids. Secondary waves (S-waves) are shear waves that are transverse in nature. S-waves can travel only through solids, as fluids (liquids and gases) do not support shear stresses. S-waves are slower than P-waves, and speeds are typically around 60% of that of P-waves in any given material.

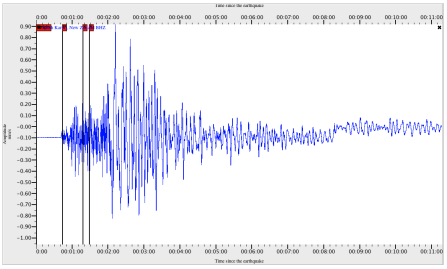

Figure 3: Seismogram of New Zealand earthquake (2011).

Questions

1. Let A and B be two seismic stations, with station B 1000 km due east of station A. An earthquake occurs somewhere (not necessarily on the line between A and B) and station A detects P- and S-wave arrivals separated by 1 minute, and station B detects P- and S-wave arrivals separated by 2 minutes. Assume P-waves travel at 4.8 km/s and S-waves travel at 3 km/s. How far apart (in km) is the epicenter of the earthquake from station A? Round your answer to the nearest integer.

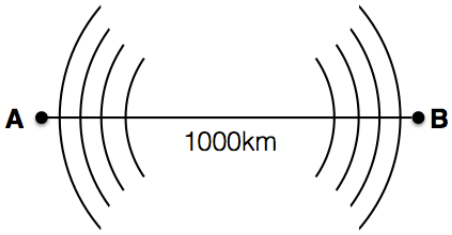

Figure 4: Seismic waves arriving at stations A and B.

2. How far away from the earthquake is station B? Round your answer to the nearest integer.
3. (Graded for completeness only.) Explain why, given the information in the problem, there are two possible locations of the earthquake.
4. Suppose a third station, located 909 km due north of station A, detects the waves separated also by 1 minute. Without doing any calculations, which of the two possible locations is the epicenter likely to be?
5. Give the angle from due east (in degrees) that one would need to travel at starting from station A to reach the epicenter of the earthquake. If the angle is north of east use a positive value, and if the angle is south of due east use a negative value. Round your answer to two decimal places.

Instructions, part deux

After reading and reflecting on these questions, complete the pre-read assignment on Canvas. This will give your coach some insight on your thinking in order to best help you before you are required to formally answer these questions.