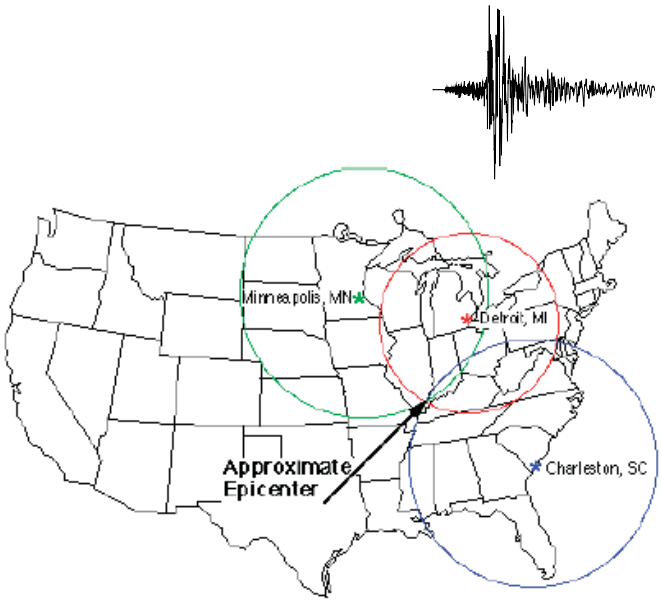
Earthquake Location*

Trilateration with real data

Overview

Many Earth science textbooks contain a description of earthquake location by trilateralation from three seismic stations. Distance of the earthquake from each seismic station is determined using the time difference between the arrivals of the primary (P) and secondary (S) waves from the earthquake.

Students use real seismograms to determine the arrival times for P and S waves and use these times to determine the distance of the seismic station from the earthquake. Seismograms from three stations are provided to determine the epicenter using the S – P (S minus P) method. Because real seismograms contain some "noise" with resultant uncertainty in locating arrival times of P and S waves, this activity promotes appreciation for uncertainties in interpretation of real scientific data.



Objectives

- Determine P and S waves arrival times on seismograms from the same earthquake,
- Determine the distance of an epicenter from each seismic station,
- Locate the epicenter of an earthquake by triangulation.

NGSS Science Standards

- Energy HS-PS3-2, MS-PS3-5
- Waves and Their Applications in Technologies for Information Transfer: MS-PS4-1, HS-PS4-1, MS-PS4-2, HS-PS4-2, MS-PS4-3, HS-PS4-5
- Earth's Systems: HS-ESS2-2

Relevant Resources

VIDEOS:

Epicenter: Determine Location of an Earthquake
www.iris.edu/hq/inclass/video/110

Travel Time Curves—Calculate distance to epicenter?
www.iris.edu/hq/inclass/video/125

ANIMATION: Travel-time Curves:
www.iris.edu/hq/inclass/animation/120

INTERACTIVE: Walk-Run: Locating earthquake using triangulation (class activity)
www.iris.edu/hq/inclass/interactive/239

FACT SHEET: "*How Are Earthquakes Located*"
www.iris.edu/hq/inclass/fact-sheet/how_are_earthquakes_located

* This activity was developed by Anne Ortiz and Tammy Baldwin and is offered through Science Education Solutions. See next page

Earthquake Location

triangulation with real data

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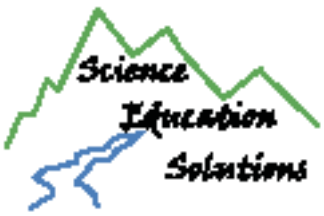

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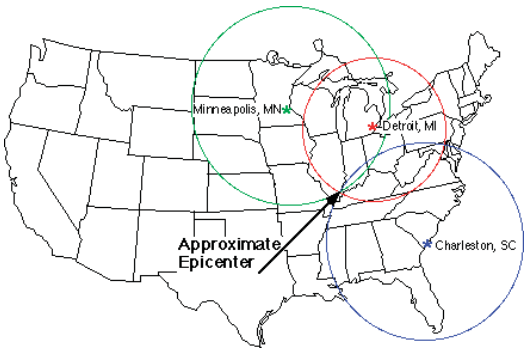
Name _____

Earthquake Location

Per _____ Date _____

By using P and S wave arrival times you can now locate an earthquake using real seismic records. The three seismograms in this activity are unfiltered station records from a single event that occurred on August 1, 1999. You will analyze the records and locate the earthquake using a method known as Triangulation.



Triangulation is a method that uses distance information determined from 3 seismic stations to uniquely locate the earthquake. On a map, circles are drawn around each seismic station. The radius of the circle are scaled to the estimated distance from the station to the earthquake. The 3 circles will share one unique intersection that locates the earthquake.

- On each of the attached seismograms determine the time of the P and S arrivals. The name of the station is represented with a three letter code on the seismogram. Record your answers below.

Pasadena, California (PAS)

P Wave Arrival Time (seconds) _____

S Wave Arrival Time (seconds) _____

- Calculate S - P Time (subtract P time from S time) _____

Dugway, Utah (DUG)

P Wave Arrival Time (seconds) _____

S Wave Arrival Time (seconds) _____

- Calculate S - P Time (subtract P time from S time) _____

Berkley, California (CMB)

P Wave Arrival Time (seconds) _____

S Wave Arrival Time (seconds) _____

- Calculate S - P Time (subtract P time from S time) _____

• For each station, determine the distance from the station to the event. This is done using the formula (S-P time) * 8 km/s.

• Multiply the S - P times for each station by 8. Record the distance below.

(PAS) distance (km) _____

(DUG) distance (km) _____

(CMB) distance (km) _____

Pasadena (PAS)

• Find the scale on the map. Using a compass, set the distance between the point and the pencil to the distance determined for the Pasadena station using the map scale. Setting the compass will require estimating.

• Place the point of the compass on the station (marked by a triangle on the map).

• Draw a circle around the station, the circle has a radius equal to the distance to the event. (The radius is the distance from the center of a circle to its edge). The epicenter of the earthquake is somewhere on the edge of that circle.

• Repeat the above steps to draw a circle around the remaining two stations. Each station should be in the center of a circle.

Event Location

• If you have picked P and S correctly and drawn circles accurately all of the circles will overlap at one point. The point where all of the circles overlap is the approximate epicenter of the earthquake.

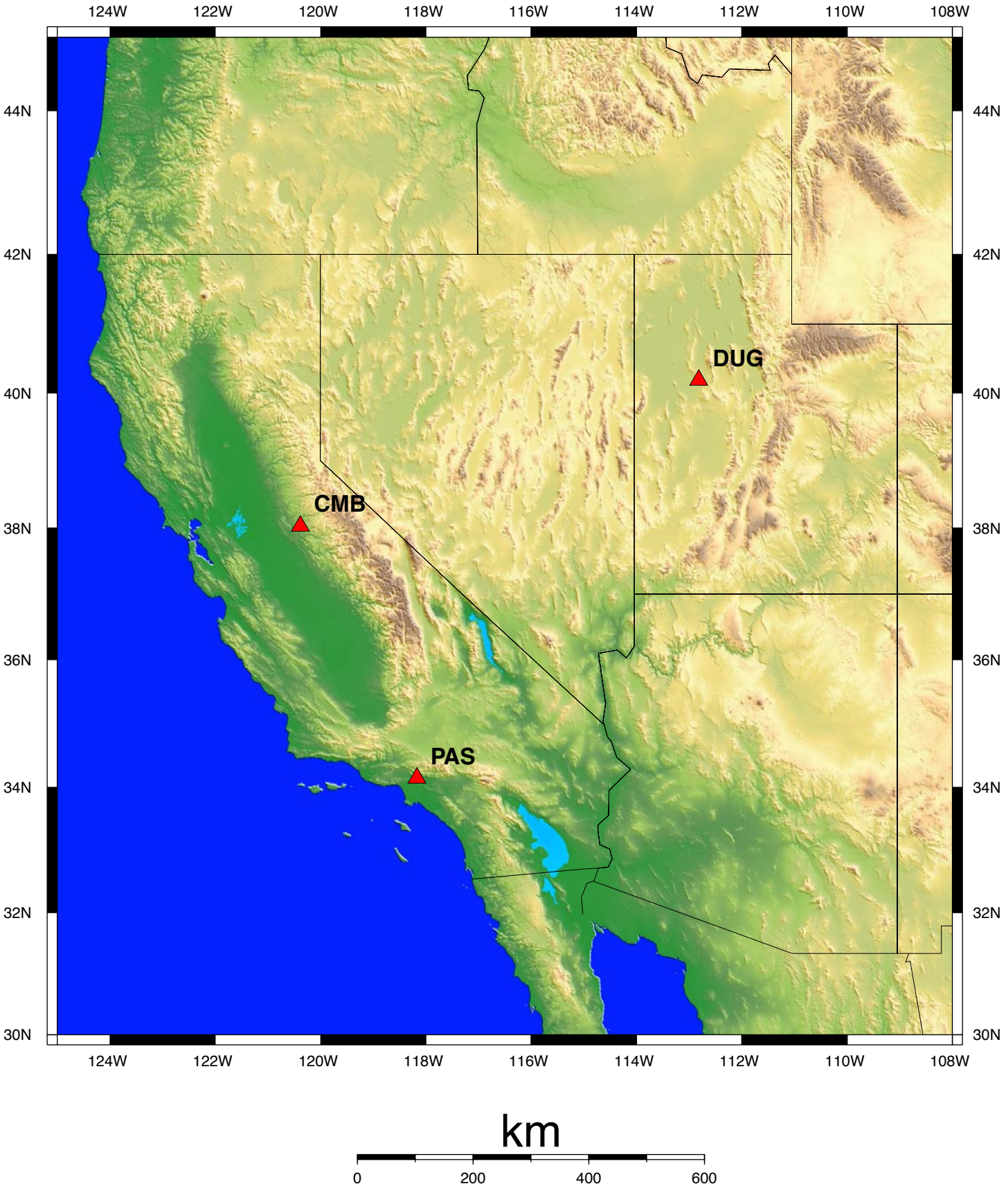
• Determine the Latitude and Longitude of the earthquake from the map and record it below.

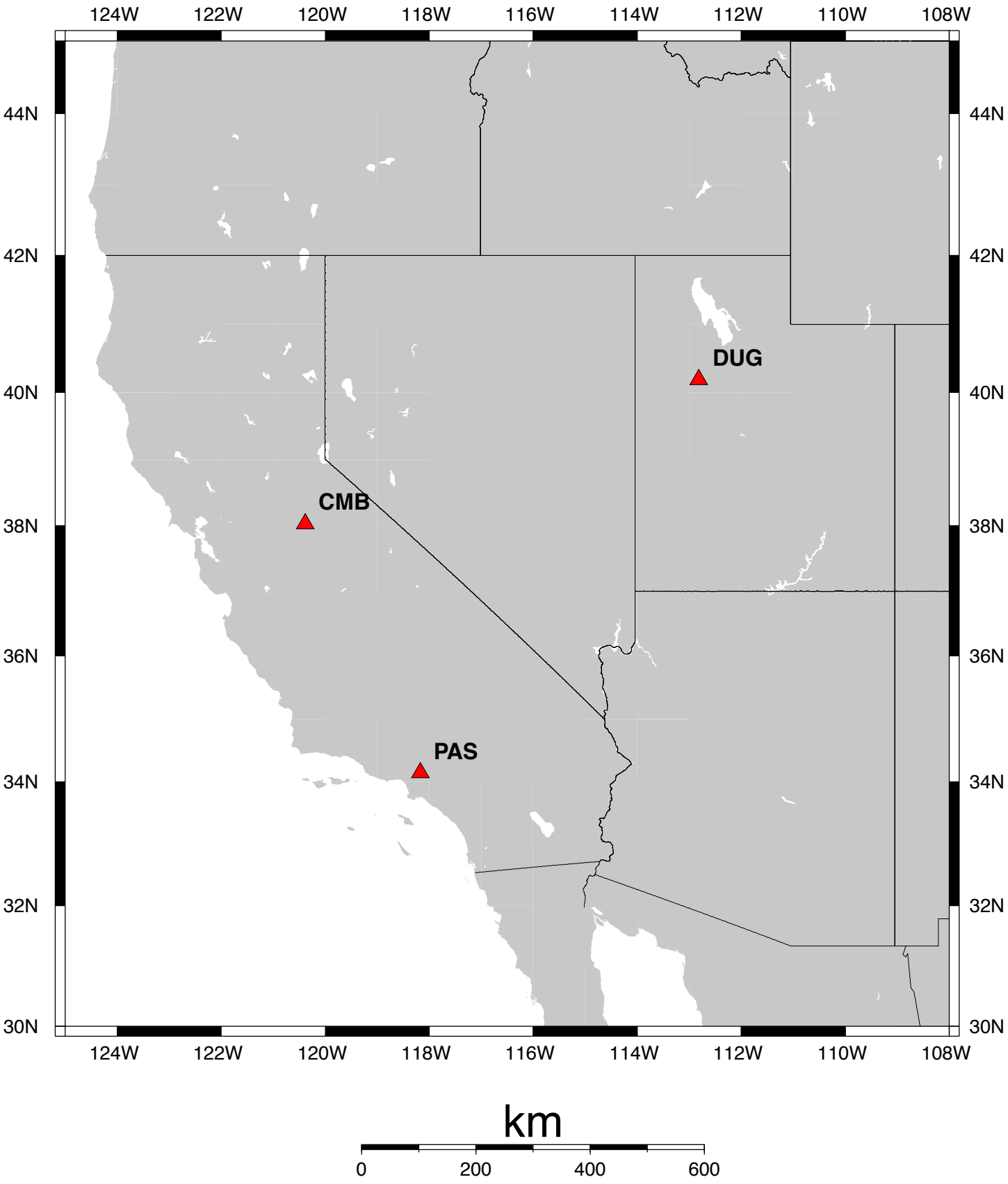
Latitude _____

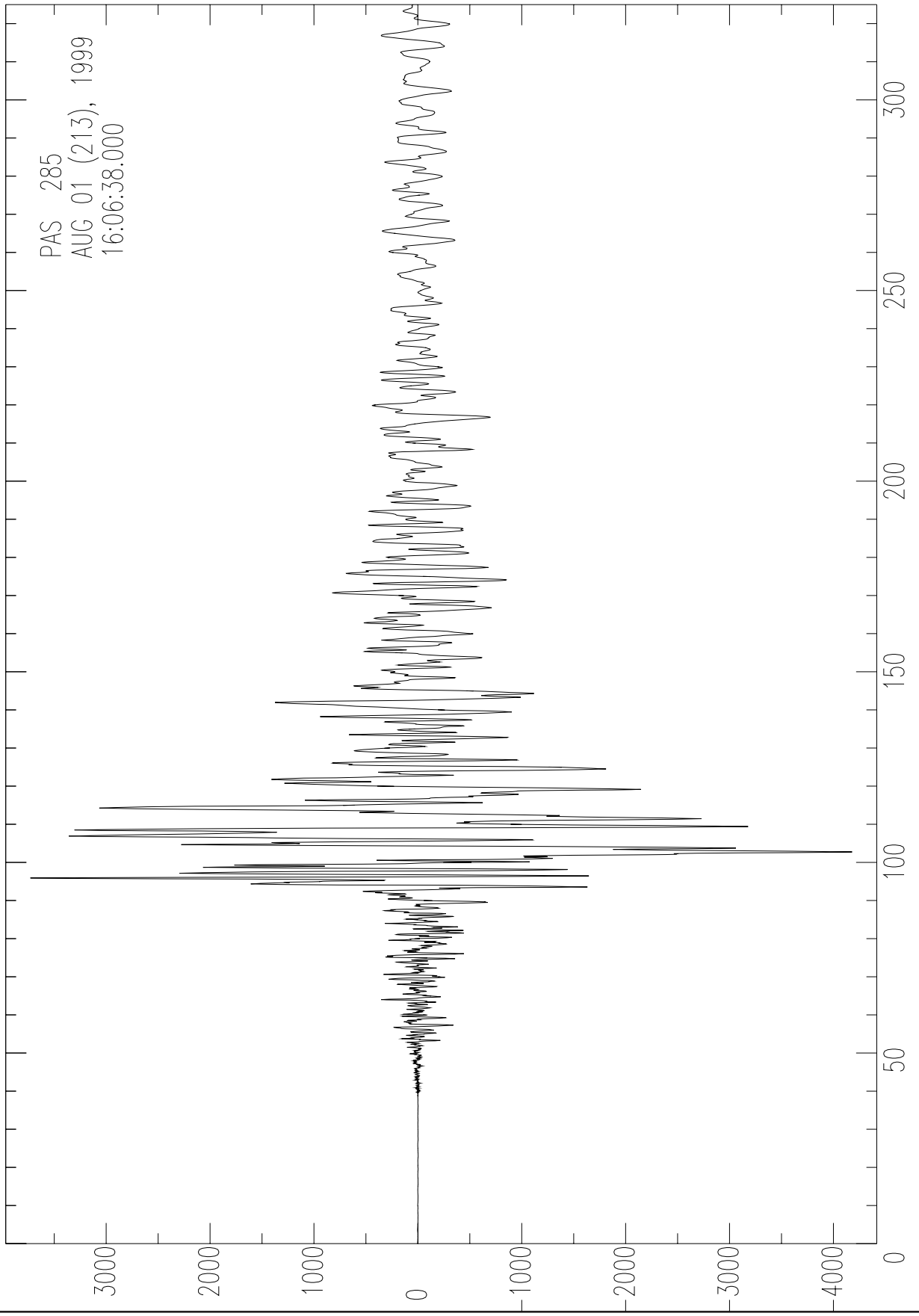
Longitude _____

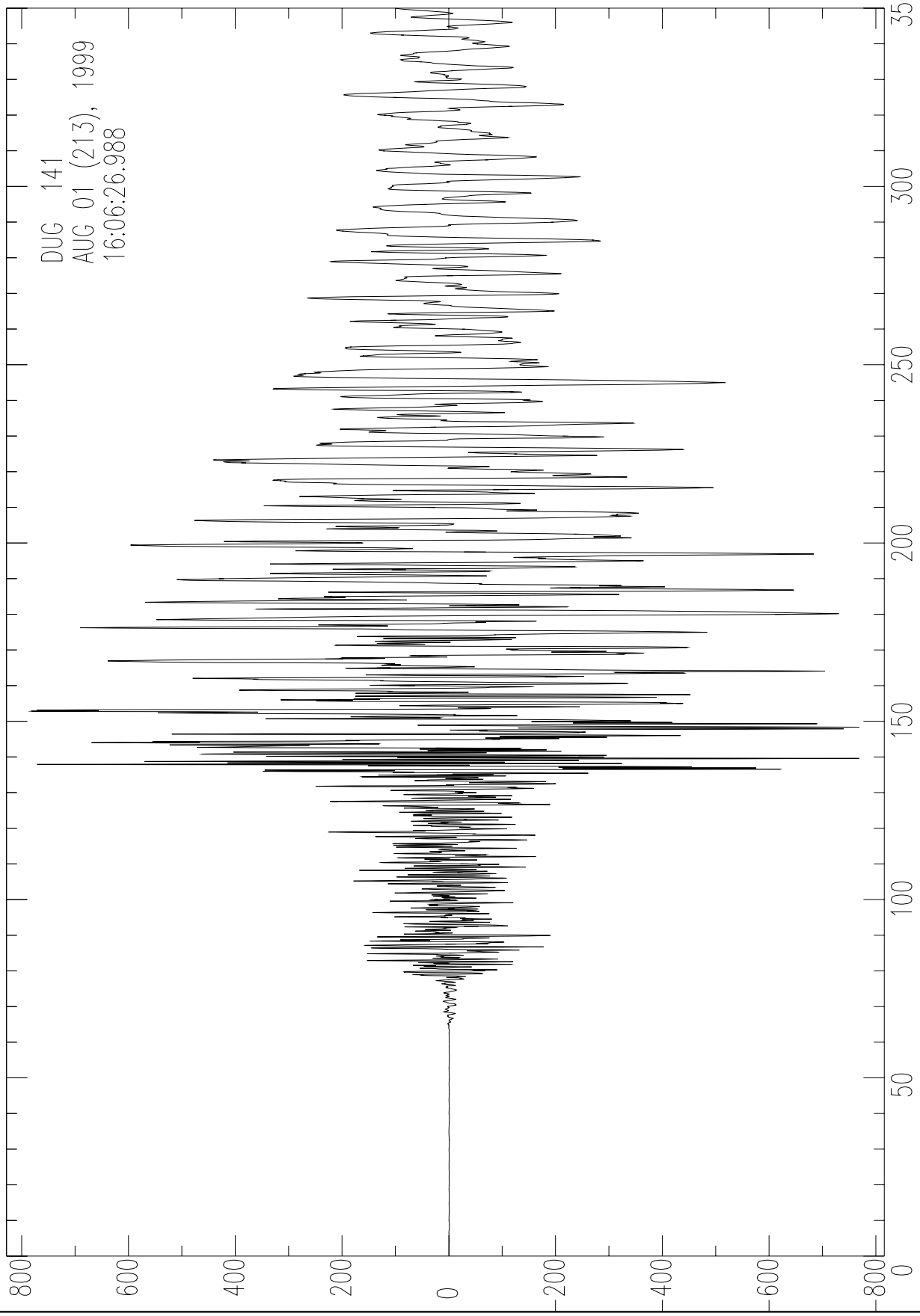
NOTE: This page is in color in the CEETEP eBinder of this document

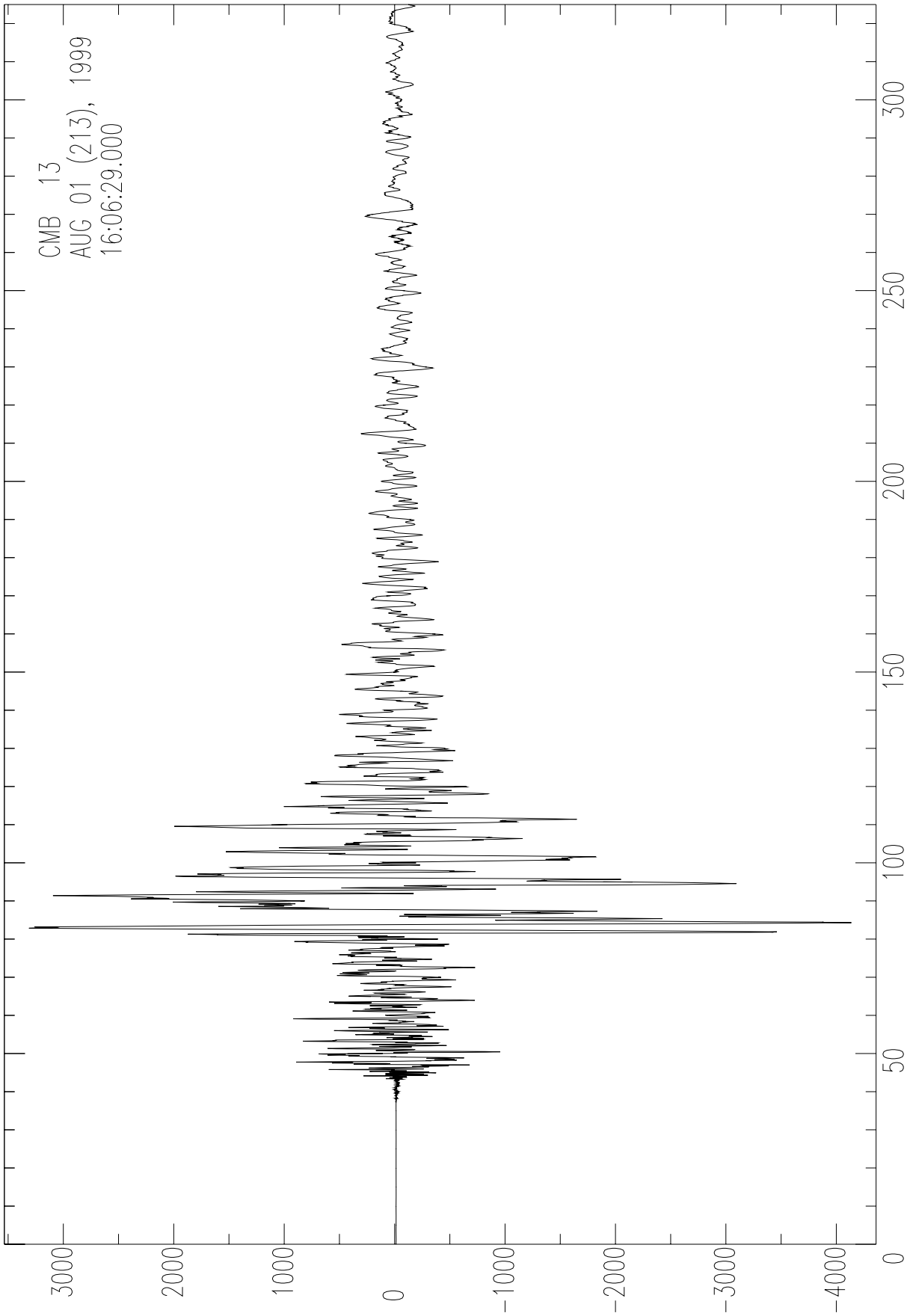
Earthquake Location











Earthquake Location - Key