Earthquake activity 7: **Locate the Earthquake Exercise**

Description: Students will learn to read a seismogram and calculate the epicentre of a Canadian earthquake.

Materials: Overhead 1: Summary of method
Seismograms and maps (Select one of the two-page groups.) for each student
Student worksheets

Teacher instructions:

1. Review seismic waves with the students.

When an earthquake occurs, vibrations initiated by fracturing of the earth's crust radiate outward from the point of fracture.

P wave: Also called **primary or compressional waves**, P waves carry energy through the Earth as longitudinal waves, moving particles in the same line as the direction of the wave. These waves are the fastest body waves. P waves are generally felt by humans as a bang or thump.

S wave: Also called **secondary or shear waves**, S waves carry energy through the Earth in very complex patterns of transverse (crosswise) waves. These waves move more slowly than P waves, but in an earthquake they are usually bigger.

2. Using the overhead provided, show the students how to calculate distance and find the epicentre.

Direct compressional waves (**P waves**) are faster moving and shear waves (**S waves**) are slower. Each type appears as a unique signature on a seismogram, the visual record produced by a seismograph.

At the recording station, the difference in arrival time of the P waves and S waves is used to calculate the distance to the epicentre of the earthquake.

Using triangulation, the calculated distances from several different seismic recording stations can be plotted to locate the epicentre. Three stations are a minimum. Accuracy increases with more stations.

3. Chose the seismogram package nearest to your community from the accompanying pages. Each package contains four seismograms on one page and a regional map on a second page. Distribute the worksheets and your chosen 2 page seismogram and map package to the students.

Group A: Eastern Canada

Answer : 10 km SE of Val-des-Bois, Quebec. (65 km northeast of Ottawa.) June 23, **2010**. Magnitude 5. Strongly felt in Ottawa. Widely felt in a 700-km radius from the epicentre in western Quebec. Felt as far away as Kentucky and Chicago. Triggered 2 landslides. Some minor structural damage.

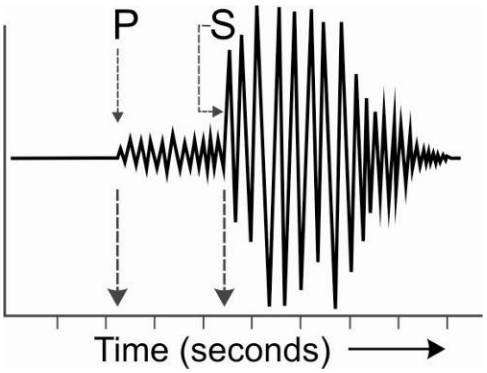
Group B: Western Canada

Answer : 19 km ENE of Duncan, BC. (Vancouver Island) Februrary 15, 2011. Magnitude 2.9. Felt in Duncan, Salt Spring Island, Ladysmith, Cowichan Bay, Chemainus and Richmond, BC. There are no reports of damage, and none would be expected.

Overhead 1: **Summary of method**

1. Identification of P wave and S wave arrival times at a seismograph station as recorded on the seismogram:

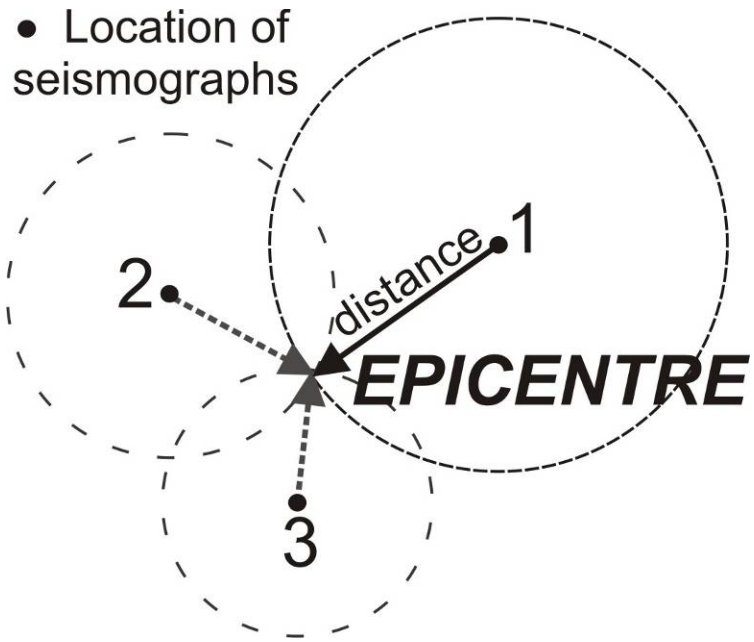
Distance to the epicentre is calculated based on the difference in the arrival times of P and S waves



2. Calculation of distance from the epicentre:

P-wave velocity = V_p = 6.2 km/sec **S-wave velocity = V_s = 3.65 km/sec** **Difference in velocity = 2.55 km/sec**	
Time taken by P waves to travel a distance (D) from the epicentre to a seismic station (km/sec)	**$T_P = D / V_p = D / 6.2$**
Time taken by S waves to travel same distance from the epicentre to a seismic station (km/sec)	**$T_S = D / V_s = D / 3.65$**
Difference in arrival time (lag time) between P waves and S waves (sec)	**$\Delta T = T_S - T_P$** **$= D / V_s - D / V_p$** **$= D/3.65 - D/6.2$** **$\Delta T = 2.55\ D / 22.63$**
Distance from the epicentre to the seismic station	**$D = 22.63\ \Delta T / 2.55$**

3. Triangulate from the seismograph stations to find the epicentre on a map.

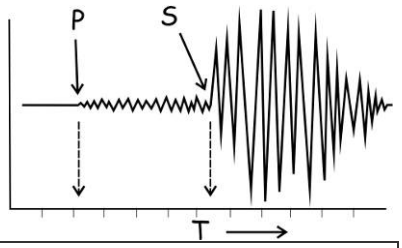


Name:_____

Find the Epicentre of an Earthquake

Background:

When an earthquake occurs, vibrations initiated by fracturing of the earth's crust radiate outward from the point of fracture. Direct compressional waves (**P waves**) are faster moving and shear waves (**S waves**) are slower. Each type appears as a unique signature on a seismogram, the visual record produced by a seismograph. At the recording station, the difference in arrival time of the P and S waves is used to calculate the distance to the epicentre of the earthquake.



P-wave velocity is 6.2 km/s and S-wave velocity is 3.65 km/s. The difference is 2.55 km/s.

Time taken by P-waves to travel a distance (D) from the epicentre to a seismic station : $T_P = D / 6.2$

Time taken by S-waves to travel same distance from the epicentre to a seismic station : $T_S = D / 3.65$

Difference in arrival time (lag time) between P- waves and S-waves is : $\Delta T = T_S - T_P$
$= D/3.65 - D/6.2$
$= 2.55\ D / 22.63$

$\therefore$ Distance from the epicentre to the seismic station is: **$D = 22.63\ \Delta T / 2.55$**

1. Answer the following questions to demonstrate your understanding of this process.

a. How long would it take P waves to travel 100 km? _____

b. How long would it take S waves to travel 100 km? _____

c. What is the lag time between the arrival of P waves and S waves over a distance of 100 km? _____

d. If the difference in arrival time of P and S waves was 20 seconds, what is the distance between the epicentre and the seismograph location? _____

2. Examine the seismograms provided by your teacher. Seismographs measured the time between the arrival of P-waves and S-waves.

a. Identify and label the arrival of the P and S waves on the seismograms.

b. Calculate the distance to the epicentre from each station.

#	Recording station	Difference in arrival time	Distance from epicentre
1			
2			
3			
4			

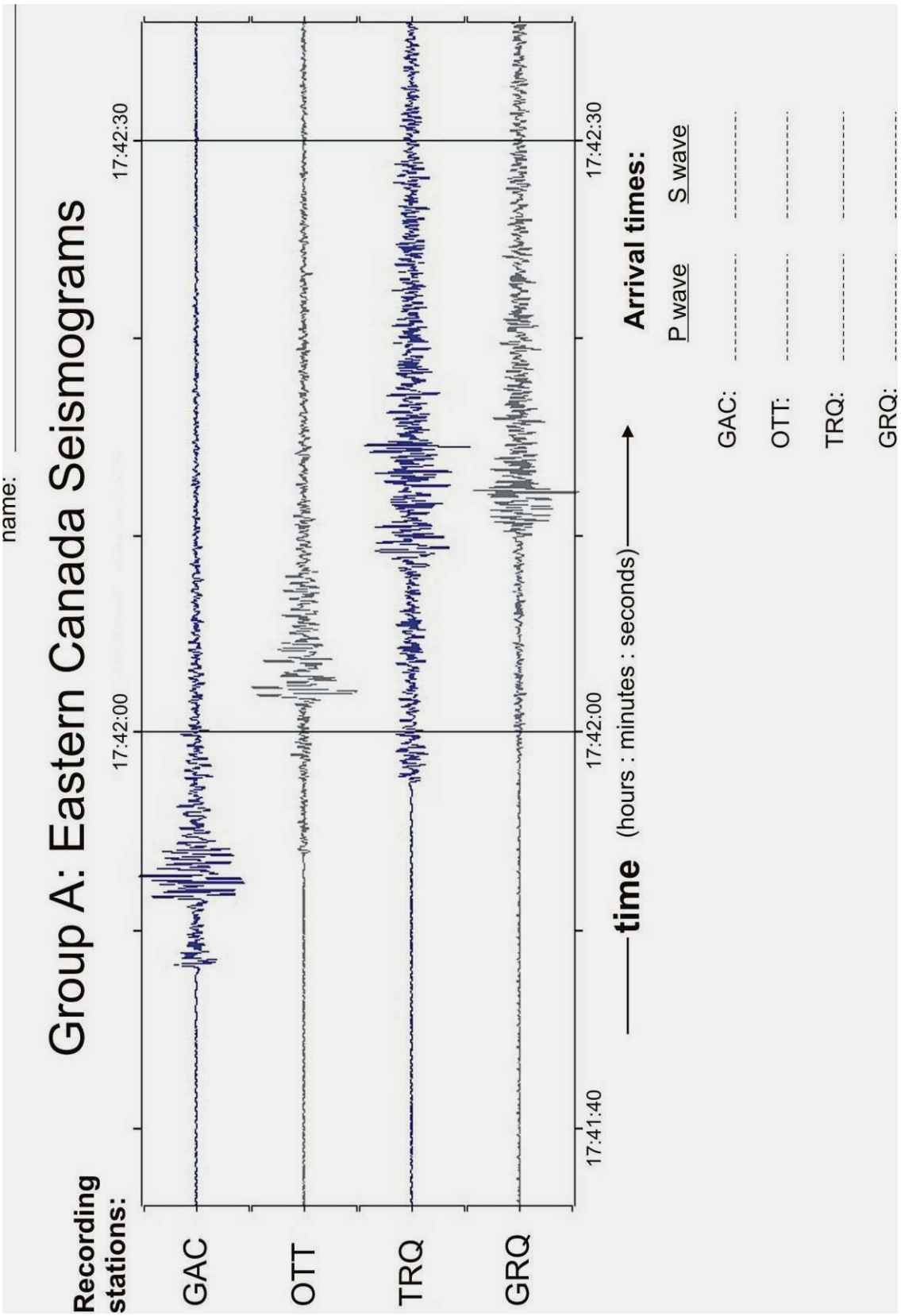
c. Triangulate the epicentre on the map. Inscribe a circle with a compass, such that the point of the compass is on the location of the recording station and the radius of the circle is equal to the calculated distance to the epicentre. Repeat for the other stations. The epicentre of the earthquake is located near the point at which the circles approximately intersect. Mark and label the epicentre on the map.

Compare the location on your map with an Atlas or Google Map.

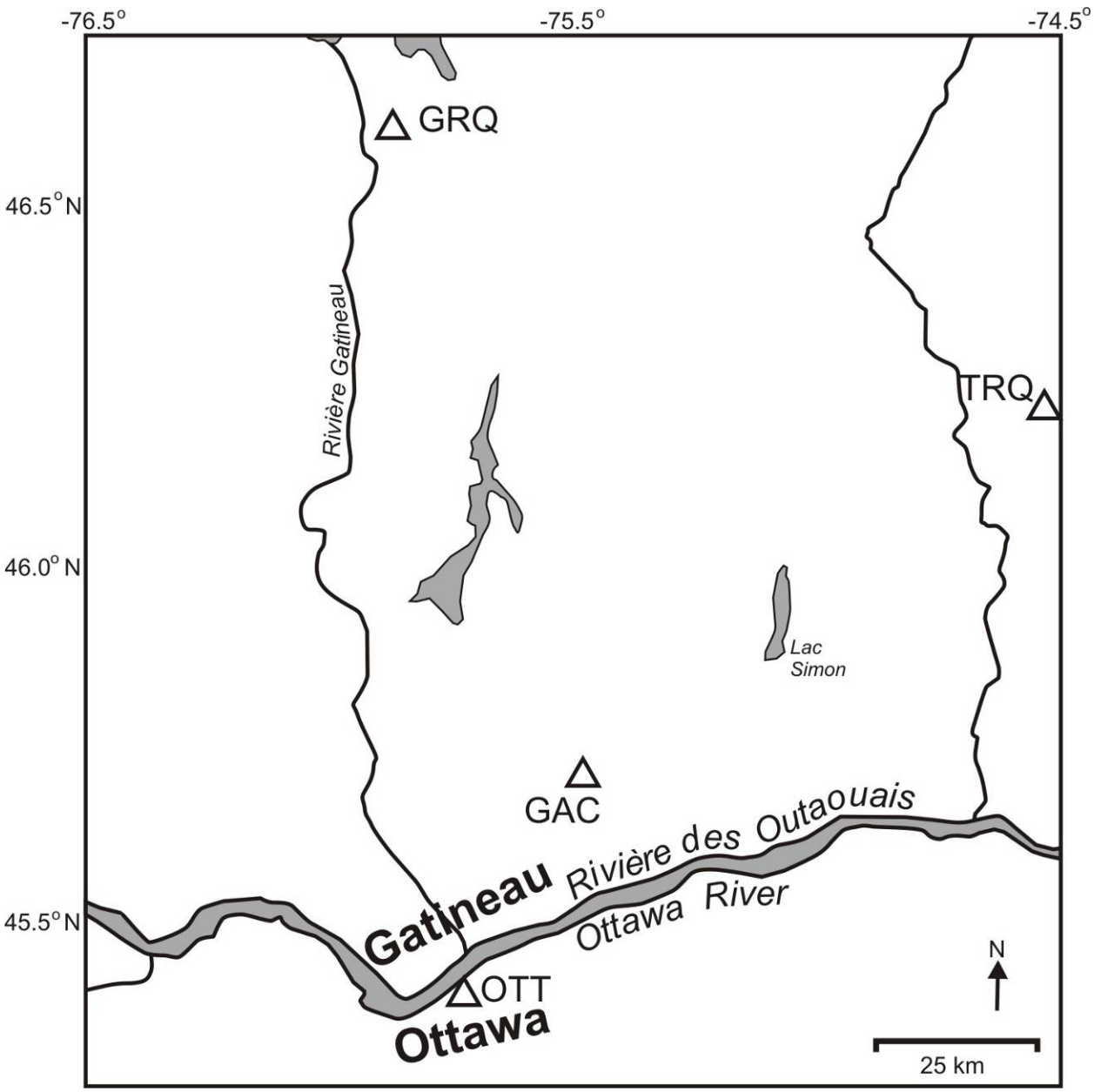
Where is the epicentre of this earthquake? Near the town of _____

What is the minimum number of stations that are necessary to find an epicentre? _____

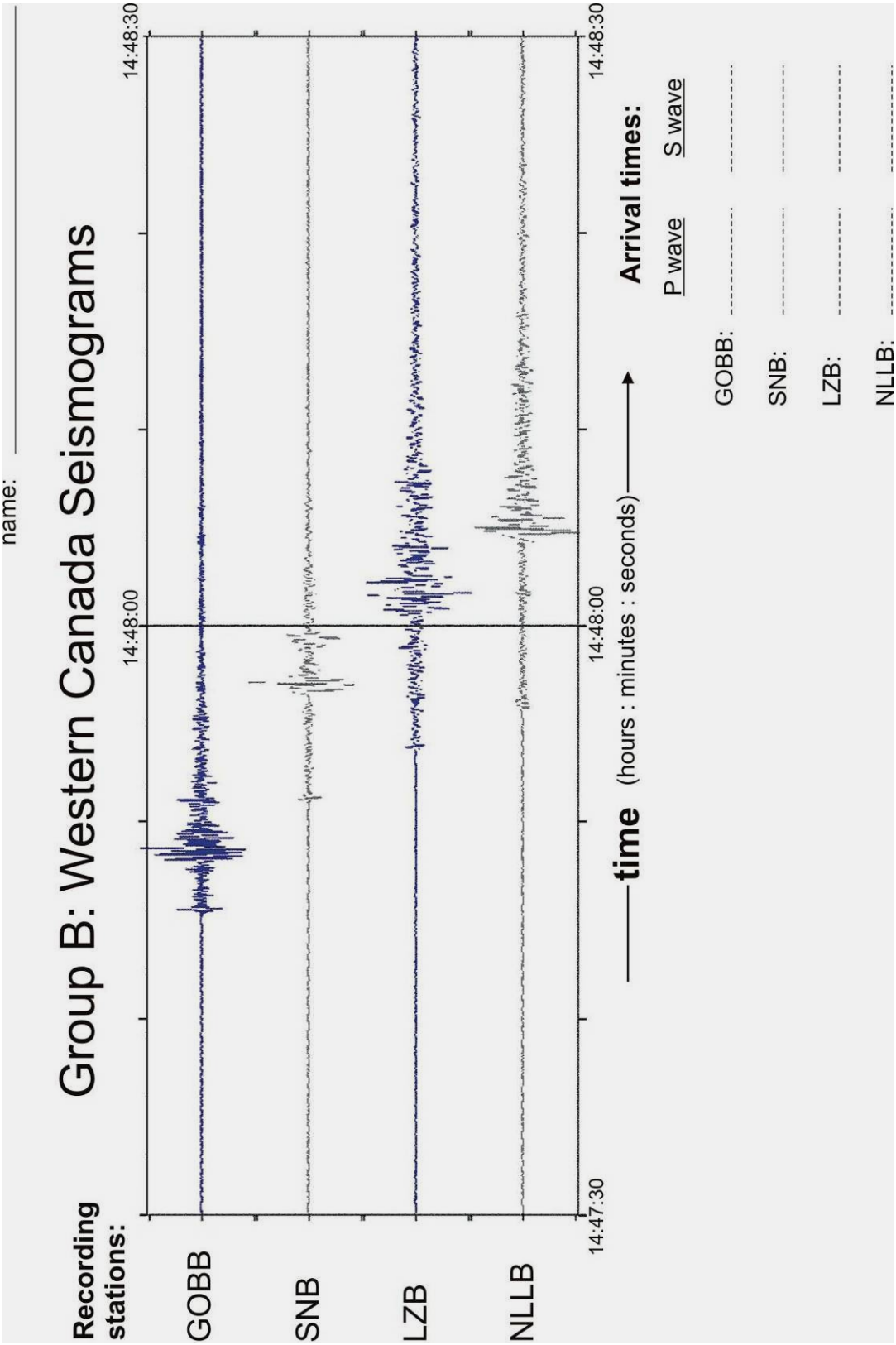
Group A. Eastern Canada: Magnitude 5 earthquake,



Group A. Eastern Canada Name: _____



Group B. Western Canada: Magnitude 2.9 earthquake



Group B. Western Canada Name: _____