Sequence 10: mechanical waves

Fiche de synthèse mobilisée (collection en français) :

- Fiche n°10 : Ondes mécaniques

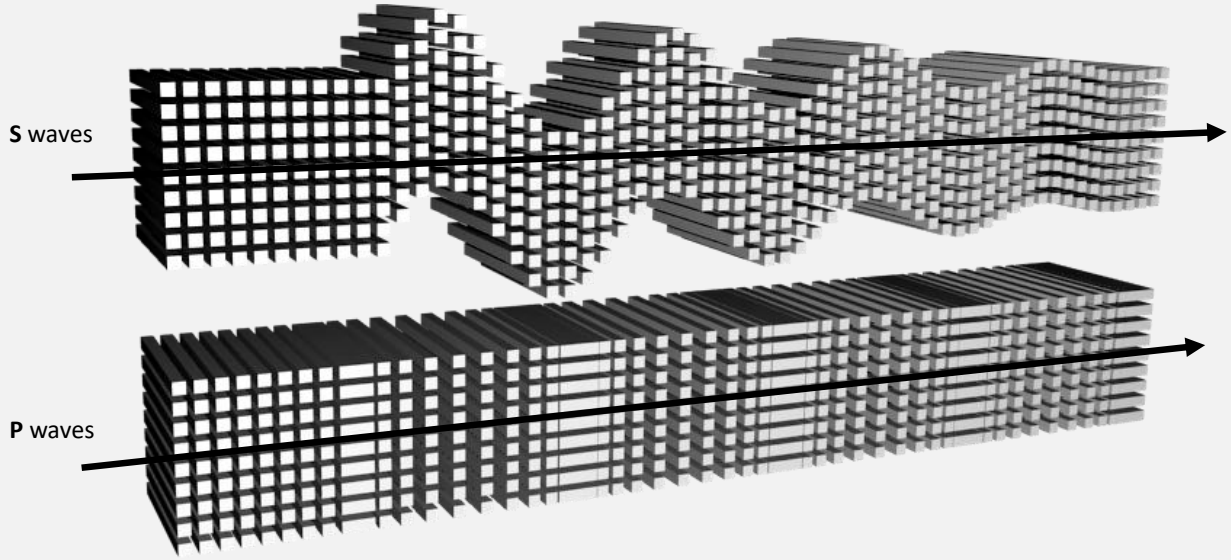
Sommaire des activités ETLV :

ACTIVITY 1: Seismic waves

DOCUMENT 1: Body waves

- P waves (primary waves) also called compression waves. The displacement of the ground which accompanies their passage is done by successive expansion and compression, parallel to the direction of propagation of the wave. They are the fastest (their speed depends on the density of the medium crossed) and are recorded first on a seismogram. Approximate speed: V_p = 6 km.s^{-1}.

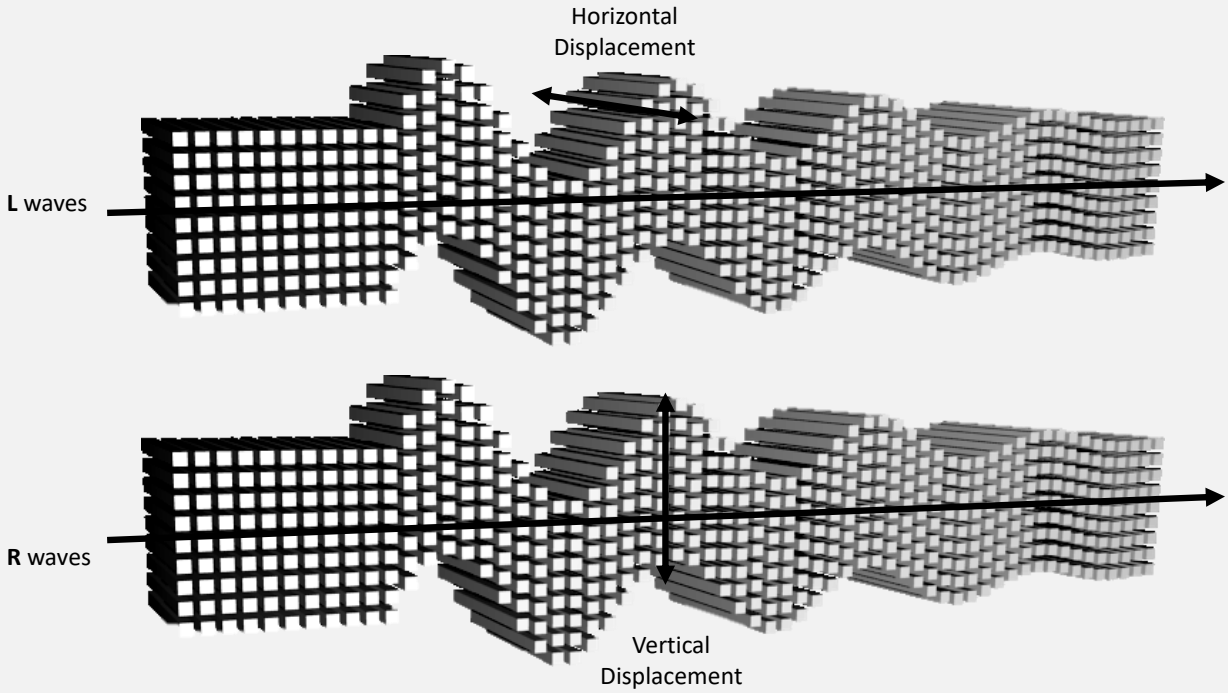
- S waves (secondary waves) also called shear waves. As they pass, the movements of the ground take place perpendicular to the direction of propagation of the wave. Their speed is slower than that of P waves, they appear second in seismograms. Approximate speed: V_s = 3.4 km.s^{-1}.



Source: Wikimedia commons

DOCUMENT 2: Surface waves

L and R waves are waves guided by the Earth's surface. The movements are emitted perpendicular to the direction of propagation. They are slower than body waves, but their amplitude is generally stronger.



Source: Wikimedia commons

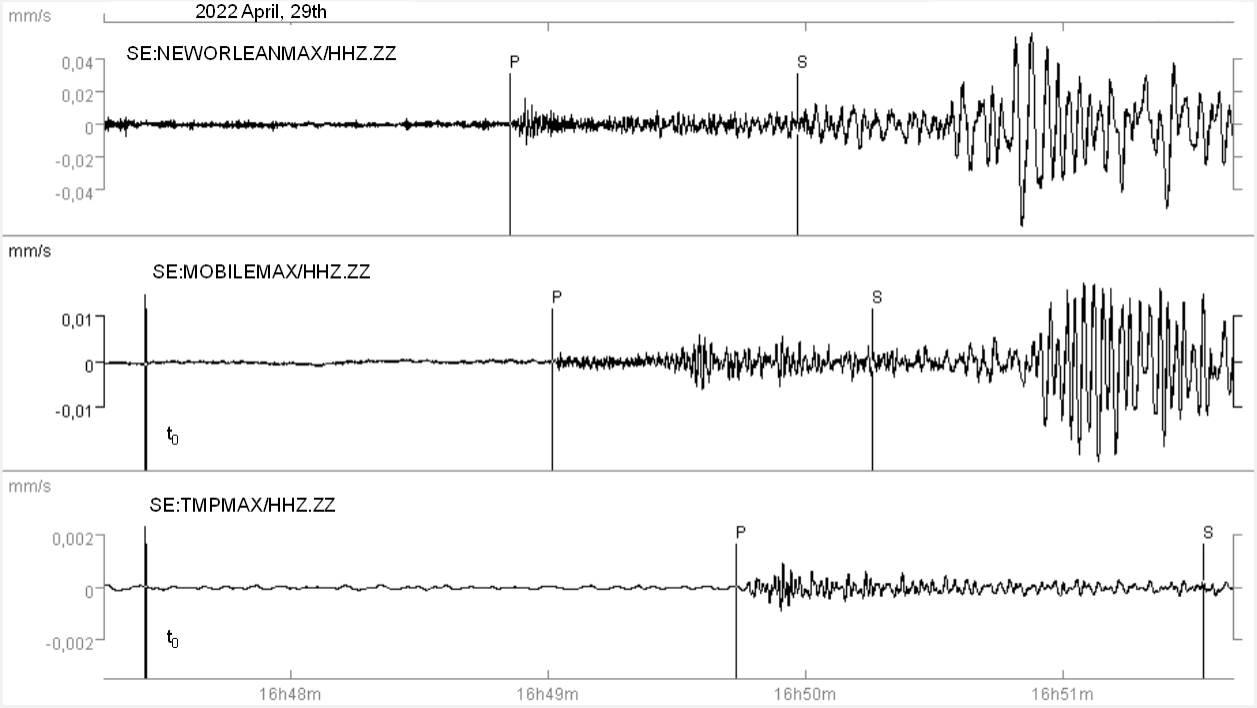
DOCUMENT 3: Vocabulary help

English	French
a record	enregistrement
an earthquake	séisme
a delay	retard

English	French
a wave	onde
the earth crust	croute terrestre
a scale	echelle

DOCUMENT 4: Seismogram

On April 29th 2022, a low magnitude earthquake took place in Louisiana and was detected by three recording stations. Here we need to precisely locate the epicenter of the earthquake.



DOCUMENT 5: Measures and notations

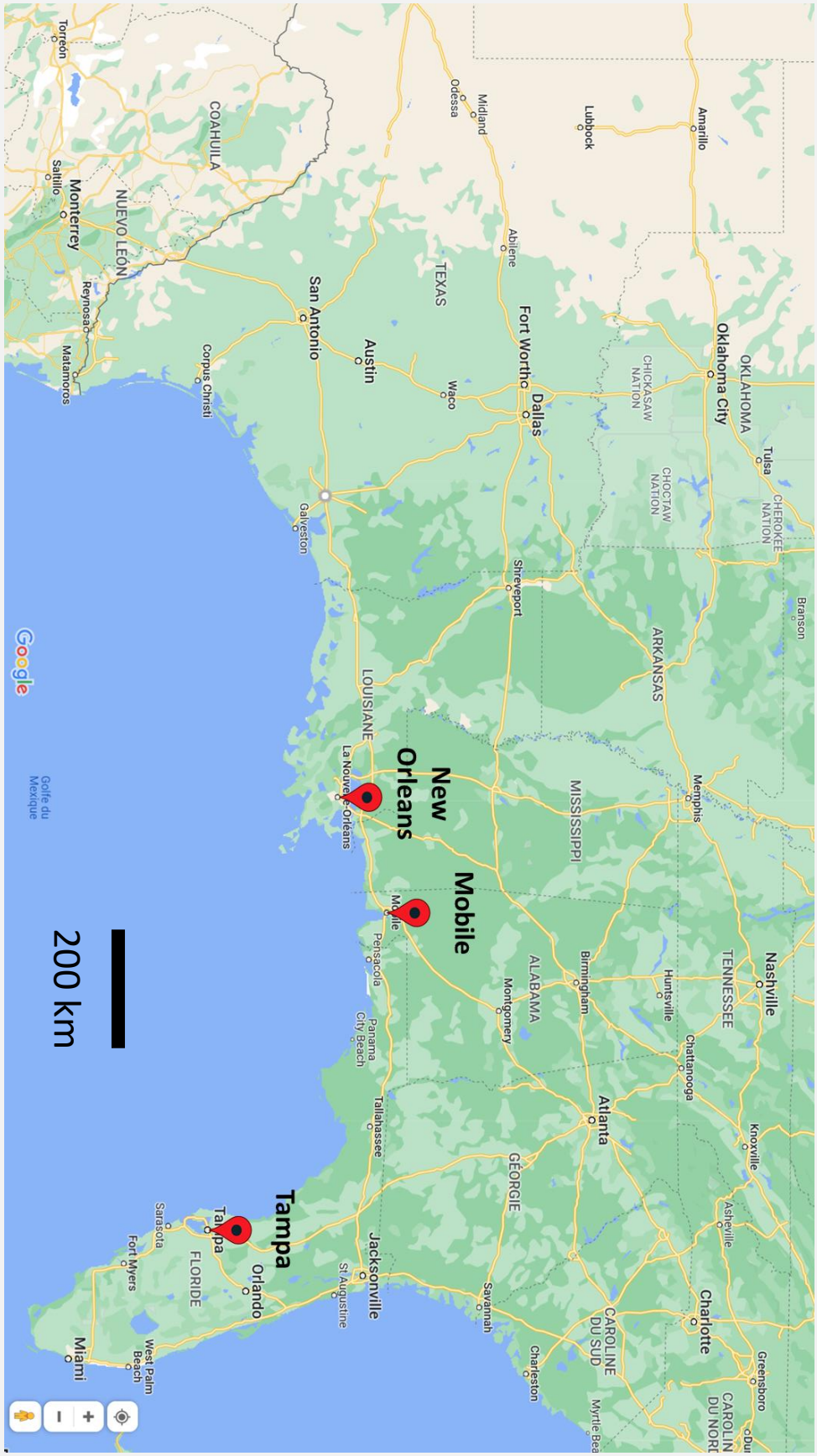
Notations:

- t_0: Time of the earthquake start;
- t_p: Time of P waves detection;
- t_s: Time of S waves detection;
- *D*: Distance between recording station and epicenter of the earthquake;

It is difficult to know precisely when the earthquake occurs, and the exact value of t_0. But recording stations can measure the difference between the recording of the p waves then the s waves which can also provide a lot of information. The measures obtained from the seismogram (document 3) are reported below:

Recording Stations	New Orléans	Mobile	Tampa
s/p time difference (t_s- t_p)	66,9 s	74,7 s	108,8 s

DOCUMENT 6: Maps and scale



Source: Google Maps

Understanding information:

1. What is a mechanical wave? Are seismic waves one of them?

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2. Classify the types of seismic waves into two categories: longitudinal waves and transversal waves.

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Computing:

3. Give the definition of delay.

Give an expression of τp, the delay of a P wave between emission and detection by a recording station. Give an expression of τs, the delay of a P wave between emission and detection by a recording station.

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4. Give the expression of v_s, the speed of S waves using *D*, t_s, and t_0.

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5. Give the expression of v_p, the speed of P waves using *D*, t_p, and t_0.

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6. Show that the expression of $\boldsymbol{D}$, the distance between epicenter and recording station can be written as:

$$\boldsymbol{D = \frac{v_S * (t_s - t_p)}{(1 - \frac{v_s}{v_p})}}$$

Using the previous formula, find the distance of each station from the epicenter of the earthquake.

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Problem solving:

The distances found do not give us the direction where the earthquake came from. Using the three distances, the map and the scale (document 6), locate the exact position of the earthquake on the map by tracing three circles.

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Did this earthquake cause any damage?

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Activity summary

What you must remember:

- **Mechanical waves**
- **Wave speed**
- **Delay**

Skills linked to the curriculum**:**

Compétences	Capacités à maîtriser	Où dans cette séquence ?
APP	Utiliser du vocabulaire spécifique	Activité 1
	Lire et comprendre des documents scientifiques	Activité 1
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activité 1
REA	• Donner l'expression de la vitesse d'une onde • Donner l'expression du retard d'une onde • Réaliser des calculs de vitesse • Démontrer une expression mathématique • Utiliser une carte et une échelle	Activité 1