Earthquake monitoring and Raspberry Shake

Version June 2025

Teaching material developed by the Swiss Seismological Service at ETH Zurich in collaboration with the University of Lausanne and the Earthquake Prevention Learning Centre (CPPS) in Sion.

Access
Published

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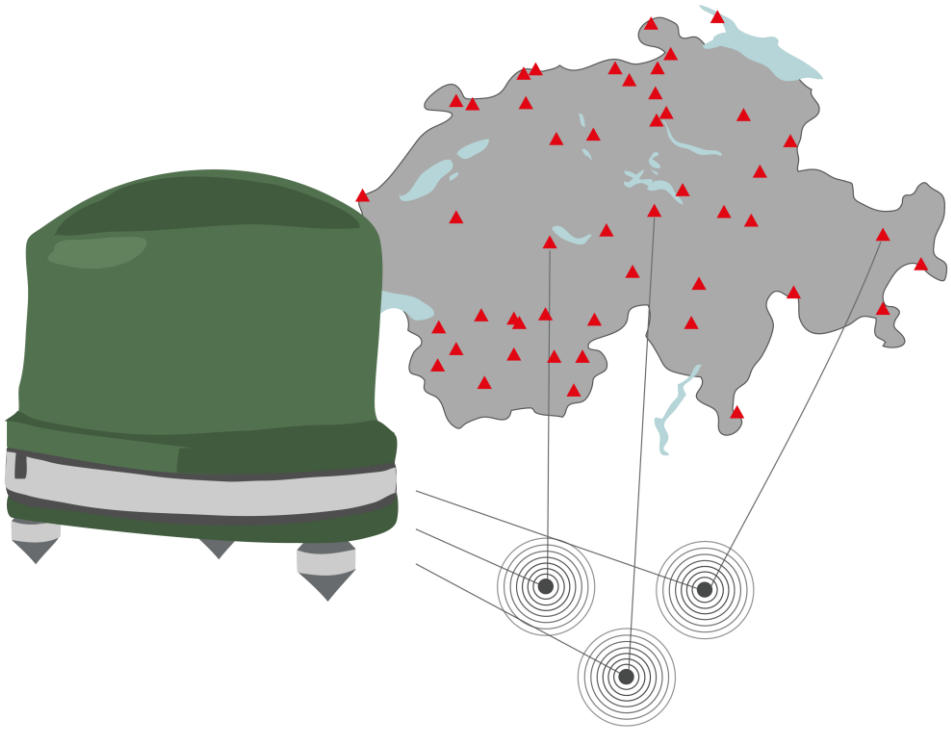
Further information
Further information on this teaching unit and other modules can be found on the website of the Swiss Seismological Service (SED) at ETH Zurich at www.seismo.ethz.ch/en/news-and-services/for-schools/teaching-resources.



Overview

Duration	– 2 x 45 min. (double lesson)
Prior knowledge	– Seismic waves – Earthquake origin – Basic terms (magnitude, intensity, epicentre, hypocentre, etc.)
Learning objectives	– Students understand what seismometers are and how they function. – Students are familiar with seismograms and spectrograms and are able to interpret them. – Students can explain in their own words what a Raspberry Shake seismometer is and how it works. – Students understand how seismologists determine the location and magnitude of earthquakes. – Students can identify different types of seismic waves and localise earthquakes using Raspberry Shake data.
Material required	– Laptop or tablet – Internet connection

Further information	**seismo@school Raspberry Shake**
	– Seismo@school Raspberry Shake Switzerland via SED, Stations
	– Seismo@school Raspberry Shake Switzerland via SED, Noise
	– Jupyter Notebook "Raspberry Shake Switzerland"
	– Interactive map for earthquake localisation using triangulation
	– Interactive tool for earthquake localisation using the bisector or grid search method (for advanced users)
	– Raspberry Shake (raspberryshake.org):
	  – ShakeNet App
	  – Station map, web app: Station View
	  – Seismograms, Webapp: Data View
	  – Localisation through triangulation, web app: Locator
	– Ideas for (Matura) projects (programming)
	
	Earthquakes worldwide
	
	– Interactive earthquake map from Earthscope
	– Interactive earthquake map from the US Geological Survey (USGS)
	– Seismic waves: propagation paths and seismic shadow zones
	– Interactive propagation of seismic waves: Seismic waves viewer
	– Visualisation of the underground movement for selected earthquake, animated: Wave fields
	– Visualisation and download of seismograms worldwide
	– Earthquake reports for significant earthquakes (for school lessons): Special earthquake reports/links
	– Wave propagation for strong earthquakes, animated: ShakeMovie

Structure and content of the module

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1. Earthquake measurements in the past and today

Since the late 19th century, seismometers have been recording earthquakes. These recordings allow us to determine where exactly an earthquake occurred (**localisation**) and how strong it was (**magnitude estimation**). To identify earlier earthquakes, researchers rely on historical reports of observed shaking and damage. From such descriptions, and with the help of statistical methods, earthquake parameters such as location, magnitude, and depth can be retrospectively estimated. Using this approach, it is possible to trace some earthquakes back as far as the first millennium.

For even earlier periods, "**natural archives**" provide valuable clues – such as broken stalactites in caves, archaeological finds, or lake sediments that document landslides triggered by strong shaking. Detecting ancient earthquakes is therefore usually **only possible for larger events** that left visible traces. Moreover, these so-called "**palaeoseismological**" methods are associated with significant uncertainties.

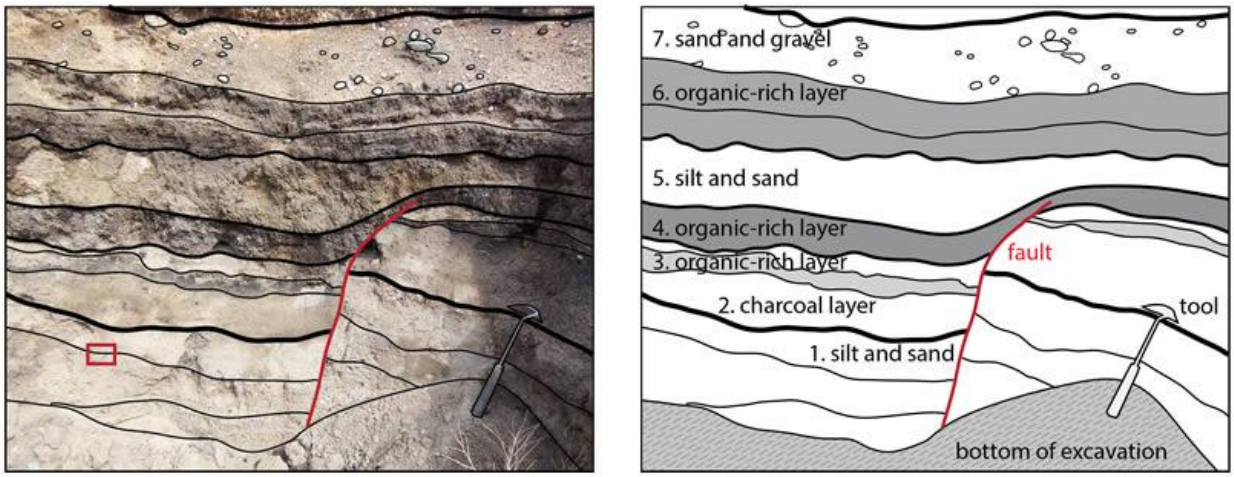


Figure 1. Example of a natural archive: A fault caused by a large earthquake on the San Andreas Fault in California, formed when the organic-rich layer 4 was at the Earth's surface. The fifth layer of silt and sand on the left side of the fault is thicker because it fills the step (fault scarp) created by movement along the fault. (Source: USGS, 29-10-2024)

The history of seismic instruments dates back to 132 AD. At that time, the Chinese scholar Zhang Heng invented the first seismoscope. The exterior of the vessel was decorated with eight dragons facing the eight cardinal directions. When an earthquake occurred, a copper ball would be released and fall from the month of one of the dragons.

There are various theories about how Zhang's seismoscope actually worked, as the original devise has not survived. From the 18th century onwards, several instruments were developed in Italy, including an electromagnetic seismometer by Luigi Palmieri in 1855, which was also capable of providing information on the duration of the earthquake.

The first **mechanical measuring devices** based on the principle of "**inertial mass**" were developed at the end of the 19th century (e.g. by John Milne and Filippo Cecchi). During an earthquake, the ground, the suspended mass at rest ("inertial mass"), and the rotating paper move together. A writing needle, attached to the inertial mass via a spring, remains stationary due to its inertia and records the relative motion on the paper as it rotates.

The graphical representation of the recorded ground motion over time is called a **seismogram**. The deflections in a seismogram, known as **amplitudes**, indicate the strength of ground motion at the location of the seismometer. Generally, the further the seismometer is from the hypocentre, the smaller the amplitudes tend to be.

The principle behind a seismometer is that a heavy body is suspended freely so that it remains at rest as an inert mass when the ground shakes.

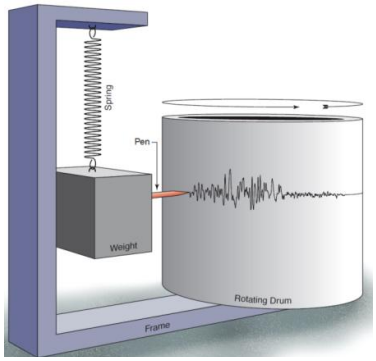


Figure 2. Seismometer that records vertical (up and down) ground movements ©IRIS.

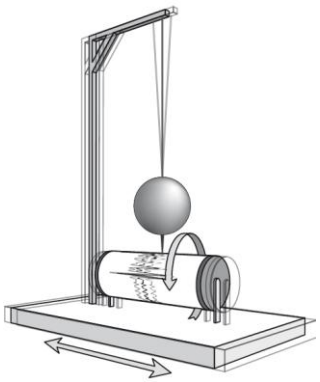


Figure 3. Seismometer that records horizontal (north-south, east-west) ground motion.

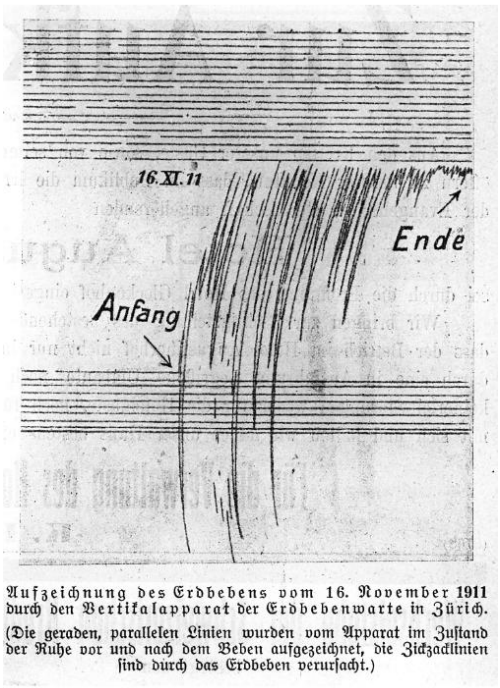


Figure 4. Seismogram of the Albstadt earthquake in southern Germany (magnitude 6.1) on 16 November 1911, recorded at the earthquake observatory in Zurich (source: Quervain, 1911 in Grolimund, R., & D. Fäh, 2021)

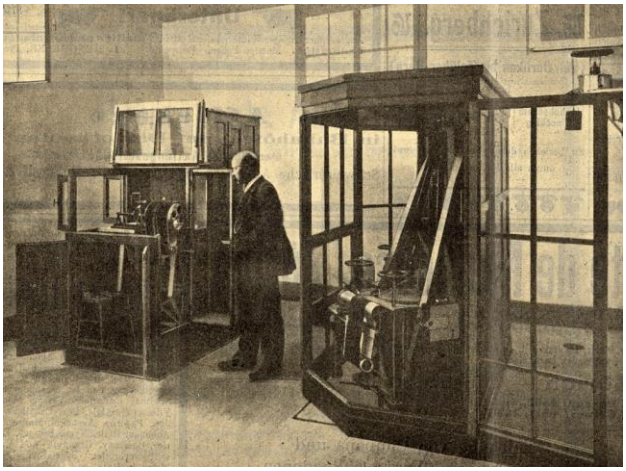


Figure 5. Instrument room of the Degenried earthquake station in Zurich at the time. Vertical seismograph on the left, horizontal seismograph on the right (source: Quervain, 1911 in Grolimund, R., & D. Fäh, 2011).

The seismometers used today are highly sensitive electromechanical devices that detect ground movements in the range of a few **nanometres** (10^{-9} metres). For comparison: a human hair has a diameter of around 70,000 nanometres!

In addition to recording and characterising earthquakes, seismometers are also used today to detect underground magma movements, investigate the structure of the subsurface for geothermal projects or monitor nuclear tests, for example.

1.1 Types of seismometers

There are various factors that influence the selection of the most suitable seismometer. In addition to cost and location, the device's sensitivity is a key consideration. Depending on the intended use, it can be decisive whether the seismometer reacts more sensitively to velocity or acceleration, as both parameters best capture different seismic events (e.g. weak local vs. strong local earthquakes).

Figure 6. One of over 200 earthquake stations operated by the Swiss Seismological Service (SED) in Switzerland.

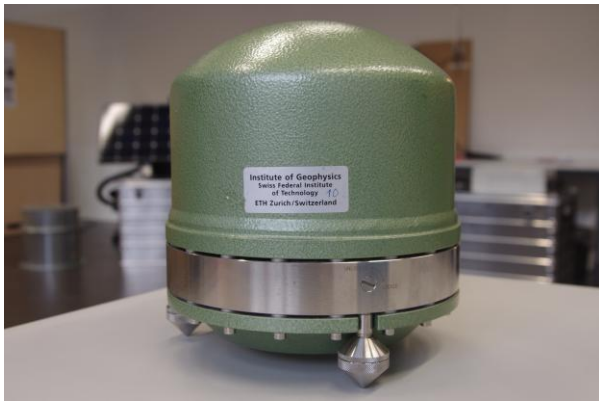


Figure 7. A highly sensitive broadband seismometer that can register the slightest ground shaking (velocities). Broadband seismometers are particularly suitable for recording weak local, moderate regional and moderate to strong global earthquakes.

Figure 8. Accelerometers can primarily register strong ground movements (accelerations). They are used to record moderate and strong local earthquakes.

Figure 9. A low-cost Raspberry Shake RS3D seismometer, which has been installed in over 40 Swiss schools as part of the seismo@school programme © Raspberryshake.org

1.2 National seismic network of Switzerland

The Swiss Seismological Service (SED) at ETH Zurich operates a network of over 200 seismic stations in Switzerland (Figure 10). The Swiss national network (CHNet) comprises various types of stations.

Broadband seismometers **Shortperiod seismometers**	**Accelerometers**	**Temporary stations** (Not on the map)
Highly sensitive network for recording the smallest vibrations. Preferably installed in quiet areas on solid rock.	For recording strong earthquakes (from magnitude 2.5). Installed in high-risk regions and urban areas.	For densifying the network in the event of increased natural seismicity or for monitoring special projects such as geothermal energy, tunnelling and dams.

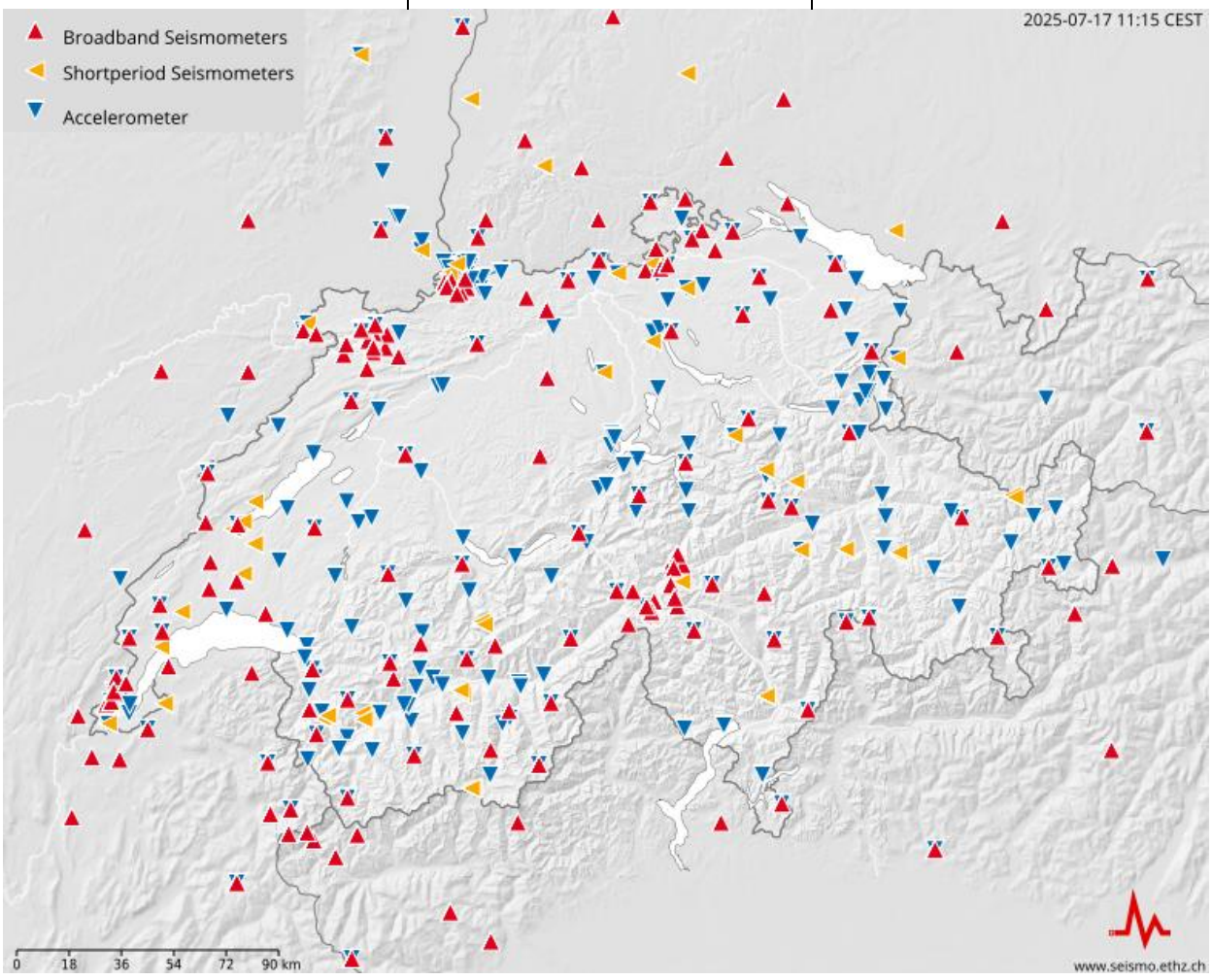


Figure 10. Map of all real-time stations monitored by the SED in Switzerland and neighbouring countries. The SED also operates temporary stations for specific projects such as monitoring seismic activity during drilling for geothermal energy projects (retreived at 17/07/2025).

Data from the seismic stations is transmitted to the SED almost in real time, where it is first analysed automatically and then reviewed manually by seismologists shortly afterwards. Earthquakes near the border can also cause damage in Switzerland. For this reason, several stations have been installed in neighbouring countries, and cross-border data exchange is actively promoted. The more stations that record an earthquake, the more accurately its location can be determined.

2. Earthquake localisation

Triangulation is a simple method for the approximate localisation of earthquakes – that is, for determining the earthquake's location: epicentre and hypocentre[1]. Key factors for localisation are the P- and S-waves. They propagate from the earthquake source (=hypocentre) through the sub-surface at different speeds and therefore reach the seismic stations at different times.

- The **P-wave** (primary wave) has an average speed of around **5.8 km/s** (kilometres per second; equivalent to 5,800 m/s) in the Earth's crust and is therefore the first to reach the seismic station.
- The **S-wave** (secondary wave) is somewhat slower at around **3.4 km/s** (equivalent to 3,400 m/s) and therefore reaches the station somewhat later.

The time interval between the arrival of the S- and P-waves at a station (**ts-tp**) can be determined from the seismogram and is characteristic of a certain distance from the station to the earthquake (Figure 11).

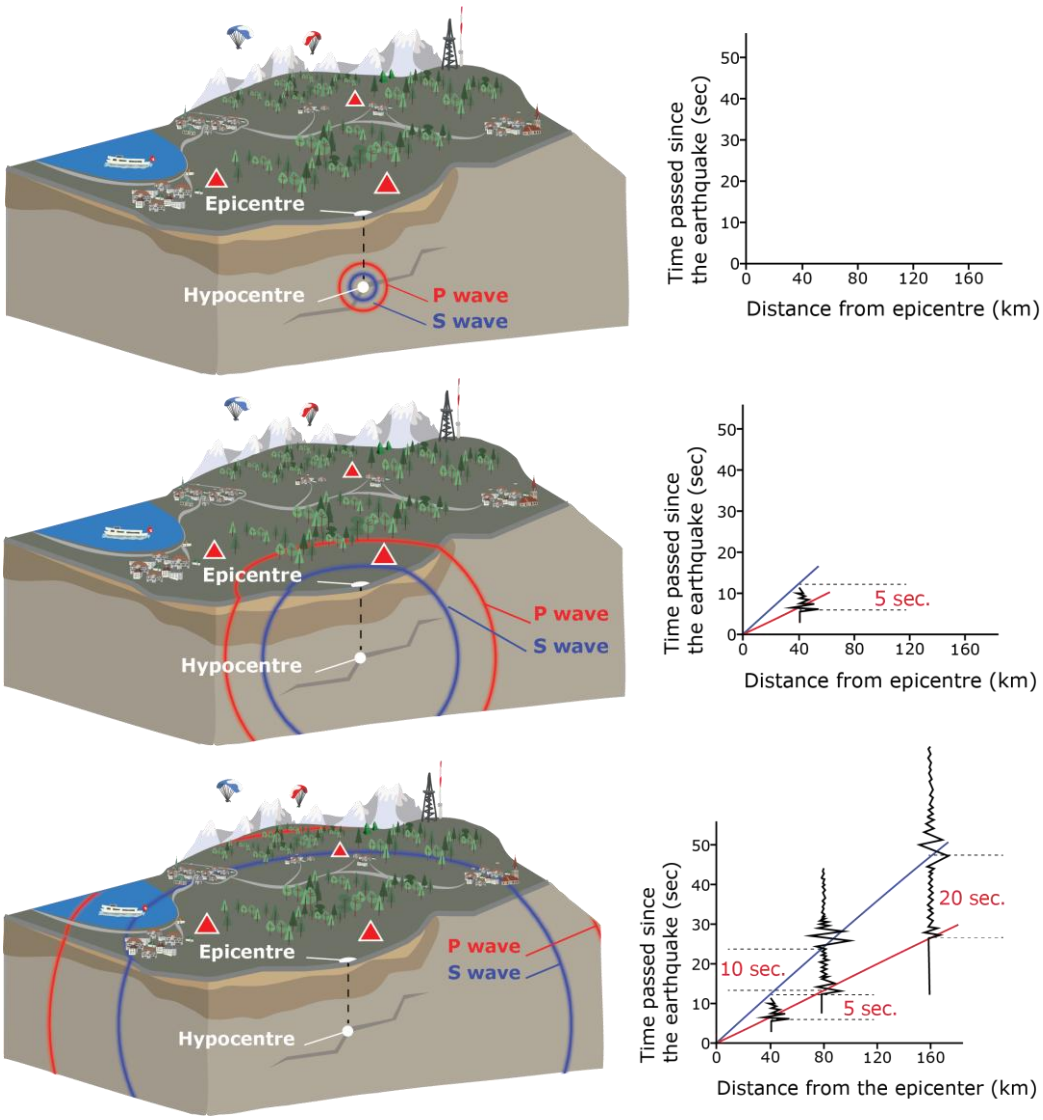


Figure 11. The time interval between the P- and S waves is characteristic of the respective distance between the earthquake and the station.

[1] Hypocentre: Place of origin of an earthquake in the Earth's interior; epicentre: Place that lies vertically above the hypocentre on the Earth's surface.

If the time interval between the S- and P-waves is 1 second, for example, the earthquake is approximately 8.2 km away from the station. At 2 seconds, the distance is 16.4 km, at 3 seconds, 24.6 km; and so on.

In general, the distance **D** (in kilometres) between the earthquake and the station can be estimated using the formula:

$$D = 8.2 * (ts - tp)$$

This distance can then be represented as a circle with radios D around the station (Figure 12): the earthquake must have occurred somewhere along this circle f the procedure is repeated with at least two additional stations; the circles will intersect at a single point. This point of intersection marks the location of the epicentre.

To determine the hypocentre of the earthquake, data from at least a fourth station is required. The distances for all stations are recalculated – not only on the surface (as circles), but also in depth (in the form of spheres). The point where these spheres intersect indicates the position of the hypocentre.

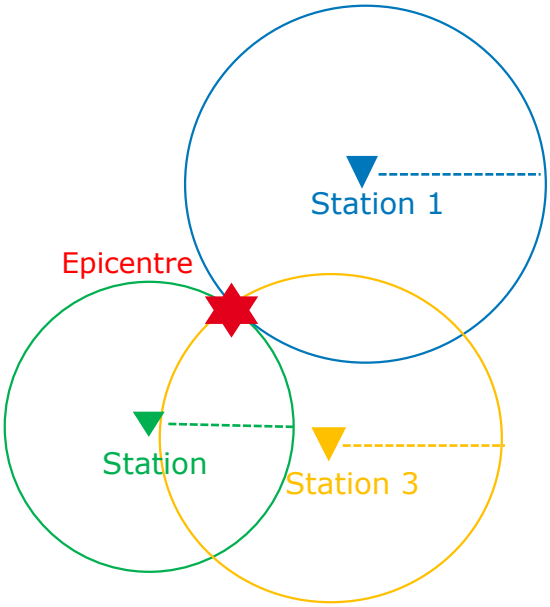


Figure 12. The principle of triangulation to locate the earthquake's epicentre.

Where does this formula come from?

$T_s - t_p = D / V_s - D / V_p$
$= D(1 / V_s - 1 / V_p)$

Therefore

$D = (t_s - t_p) / (1 / V_s - 1 / V_p)$
$= (t_s - t_p) / (1 / 3.4 - 1 / 5.8)$
$= (t_s - t_p)\ 8.2\ km/s$

t_p: Arrival time of the P-wave

t_s: Arrival time of the S-wave

V_p: Average velocity of the P-wave (5.8 km/s)

V_s: Average velocity of the S-wave (3.4 km/s)

D: Distance between earthquake and seismic station

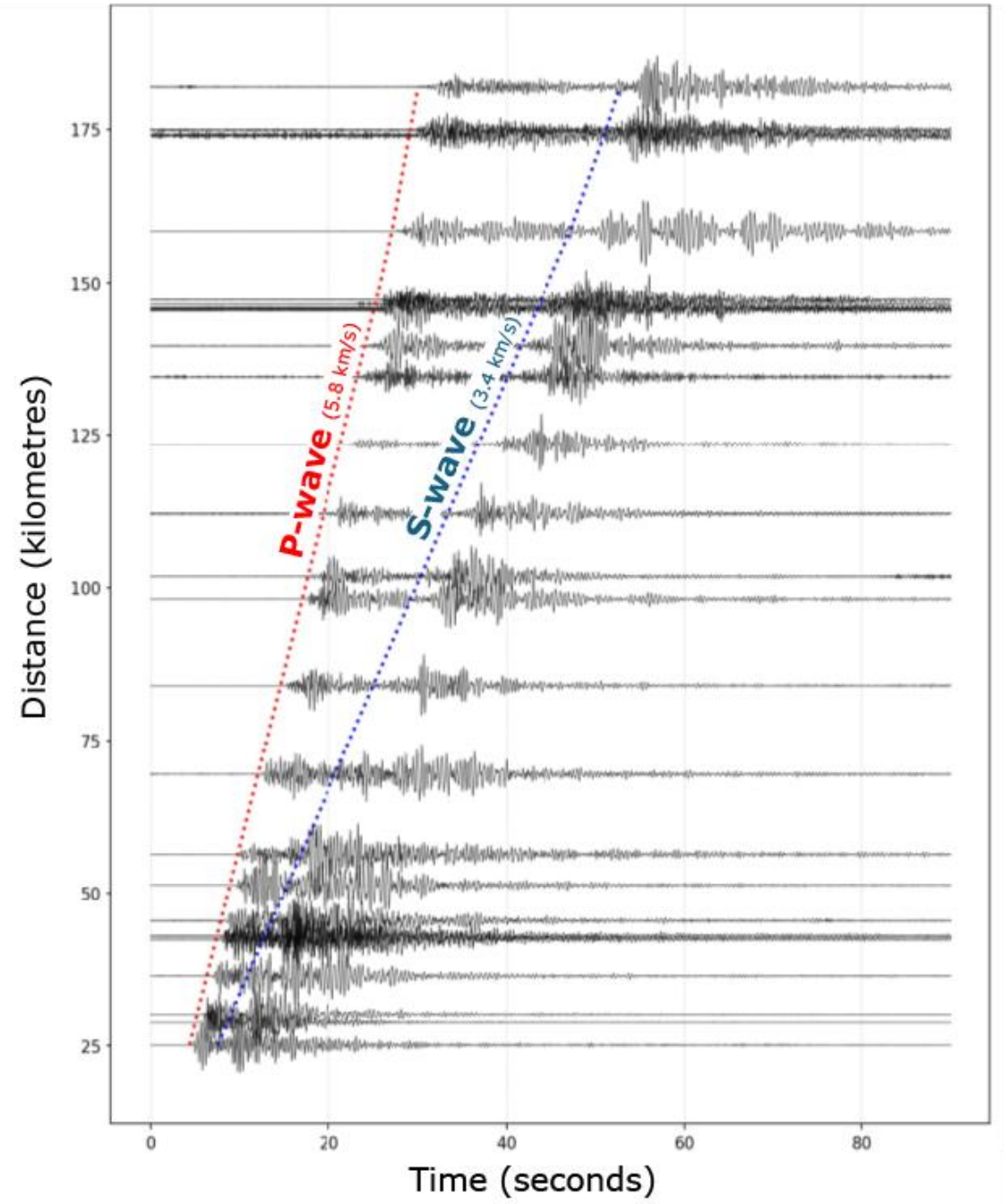
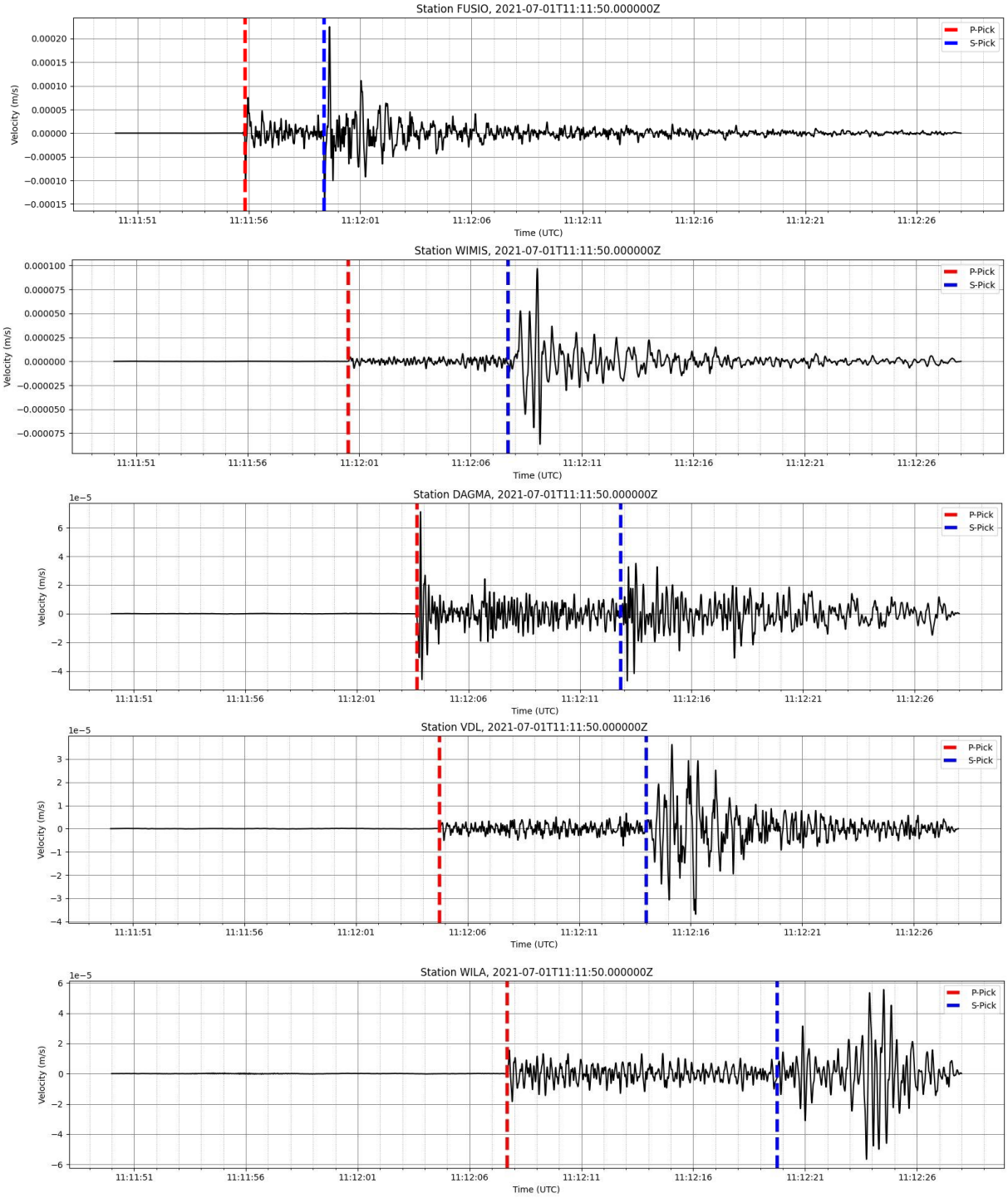


Figure 13. Various seismic stations in Switzerland recorded the earthquake in the upper Sihl Valley (canton of Schwyz) on 4 June 2024, resulting in the seismograms shown here. The y-axis indicates the distance of each station from the epicentre, while the x-axis represents the time evolution of the recorded ground motion at each station. The greater the distance from the epicentre, the later the P- and S-waves arrive. The time interval between their arrivals increases with distance due to the difference in their propagation speeds.

Task 1: Localise an earthquake

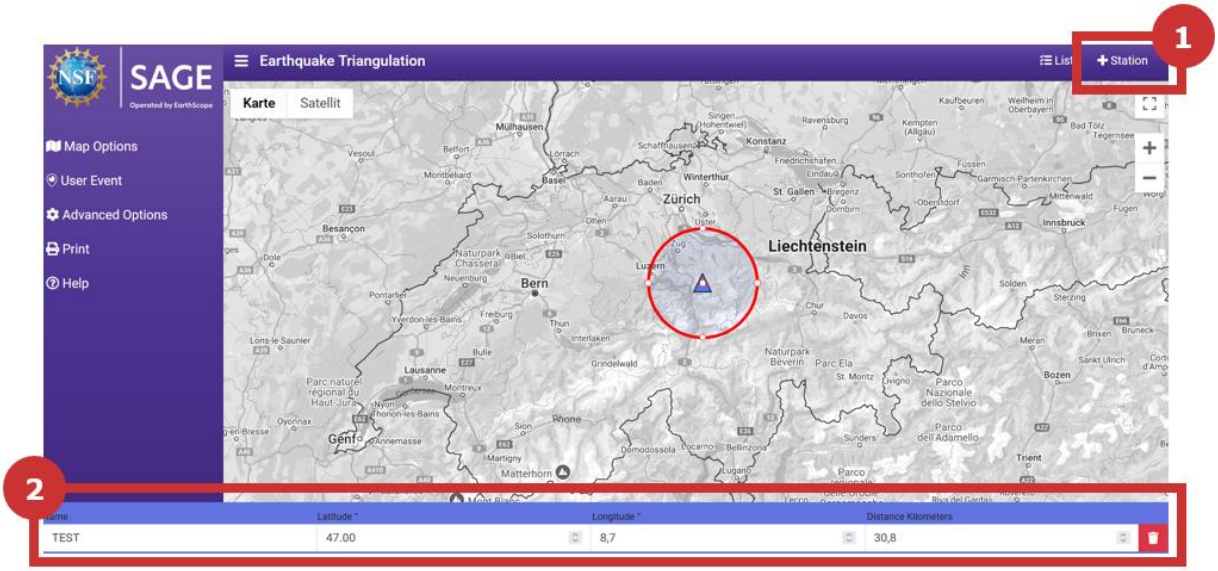
Here you can see the seismograms recorded by five seismic stations during an earthquake in Switzerland. The red lines show the arrival of the P-wave and the blue lines the arrival of the S-wave.



1. Determine the arrival times of the P- and S-waves for at least 3 stations and fill in the table:
2. Go to the following website: https://dev.iris.edu/app/triangulation

Station name Latitude and longitude	**Time interval** (in seconds) **ts-tp**	**Distance D** (in kilometres) $D = 8.2 \times (ts - tp)$
FUSIO (46.46°N; 8.66°E)		
WIMIS (46.67°N; 7.62°E)		
DAGMA (47.23°N; 8.01°E)		
VDL (46.48°N; 9.45°E)		
WILA (47.42°N; 8.91°E)		

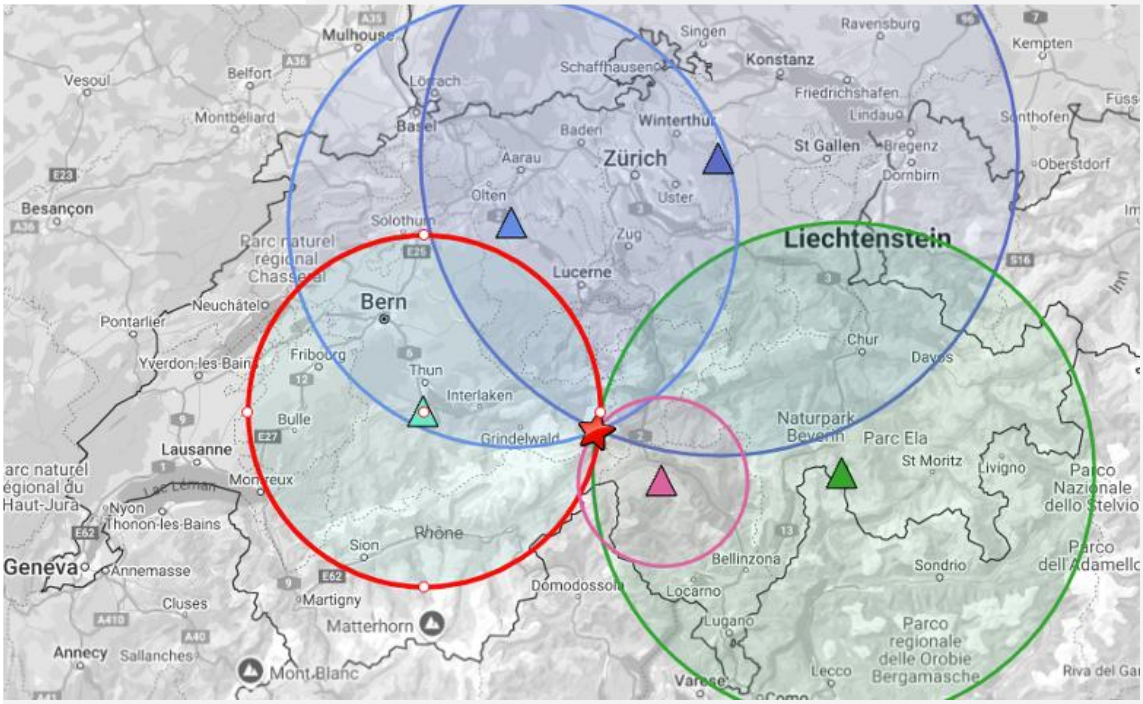
3. Click on "+Station" at the top right. A pop-up window now appears at the bottom of the page.
4. For each station you have determined in the table above, enter the name, the longitude and latitude and the distance D.
5. You should now see a triangle and a circle on the map.
6. Zoom into the map:



Do the circles intersect at a single point? If so, this is the epicentre of the earthquake. If not, check the calculations in the table above and re-localise the earthquake if necessary.

The earthquake occurred on 1 July 2021 at 11:11:50 UTC. Now visit the website of the Swiss Seismological Service (www.seismo.ethz.ch) to see if you can find the earthquake listed there. Have you located it correctly? Search the website for more information about the event (e.g. magnitude, ShakeMap, etc.).

Solution task 1: Localise an earthquake		
Station name Latitude and longitude	**Time interval** (in seconds) **ts-tp**	**Distance D** (in kilometres) **D=8.2 *(ts-tp)**
FUSIO (46.46°N; 8.66°E)	3.5	28.7
WIMIS (46.67°N; 7.62°E)	7.2	59.04
DAGMA (47.23°N; 8.01°E)	9.1	74.62
VDL (46.48°N; 9.45°E)	9.3	76.26
WILA (47.42°N; 8.91°E)	12.1	91.02



This is the earthquake near Oberwald (VS) with a magnitude of 4.0.[2]

Triangulation is a simple but imprecise method for localising earthquakes and is therefore not used in practice. The main reason for this is that it is difficult to recognise the exact time of arrival of P and S waves in the seismogram. In addition, the earthquake waves propagate underground in a very complex way because the different rock layers have different thicknesses, and the waves propagate through them at various speeds. In practice, seismologists and computer programs usually measure the arrival times of the P-waves at many different stations. With the help of local underground models, which are based on extensive data from previous earthquakes, they can calculate the exact location.

More information
Further earthquake localisation tools from EarthScope: https://www.iris.edu/app/eq-locate/method

[2] www.seismo.ethz.ch/en/earthquakes/switzerland/eventpage.html?originId=%27c21pOm-NoLmV0aHouc2VkL3NjMjBhZy9PcmlnaW4vTkxMLjIwMjEwNzAxMjAzNzI2LjgyOTAzNy42ODA3MA==%27&date_ch=2021-07-01&time_ch=13:11&region=Oberwald%20VS&magnitude=4.0

3. Raspberry Shake

The Raspberry Shake is a low-cost seismometer capable of measuring ground motion. Its measurement accuracy is lower than that of a professional-grade seismometer. However, due to its affordability and ease of use, it can also be operated by non-professionals.

The Raspberry Shake (models RS1D or RS3D) consists of two main components:

- **One or three high-precision sensors** (geophones)
  These measure ground motion – more precisely, ground velocity – either in the vertical direction only (RS1D) or in both vertical and horizontal directions (RS3D), depending on the model.

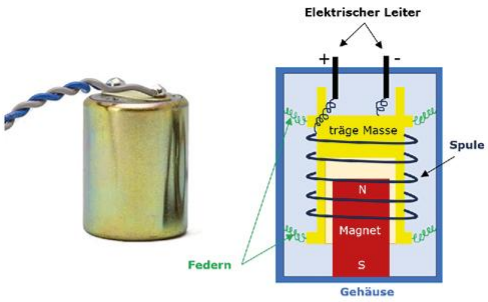
- **One analog-to-digital converter**
  This component converts the analogue signals recorded by the sensors into digital signals that can be processed by a computer.

When a magnet moves through a coil, an electric current is induced in the coil. A **geophone** works according to this principle: a coil is suspended from a spring, and a magnet is positioned inside the coil. As the ground moves, the relative motion between the magnet and the coil generates an electrical signal.

The **analog-to-digital converter converts** then transforms this electrical signal into a digital one, which can be interpreted by computers. Figure 15 provides an overview of the key components of the Raspberry Shake and their respective functions.

Figure 14. Raspberry Shake RS3D © Raspberryshake.org

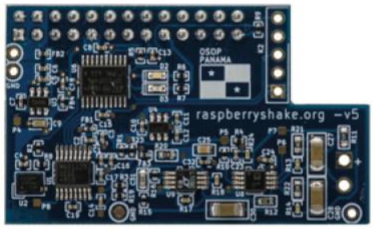
ANALOG DATA



The sensor converts the movements of the ground into electrical voltages.

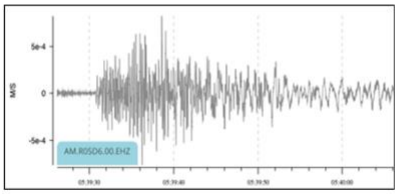
The sensor contains a magnet in a coil. The magnet is connected to the housing and thus to the ground. The coil is suspended on springs together with a weight (inert mass) and surrounds the magnet without touching it. When the ground moves, the magnet moves within the coil, which remains stationary. This generates an electrical current in the coil.

DIGITAL DATA



The current in the coil is converted by a **digitizer** into a signal that can be processed by the computer and displayed as a seismogram.

SEISMOGRAM



Seismogram (vertical component) of the earthquake that occurred on 5 October 2021 in Arolla (VS) with a magnitude of 4.1, recorded on a Raspberry Shake seismometer located about 30 kilometres from the epicentre.

WEB ACCESS

All data from Raspberry Shake seismometers worldwide can be accessed on the website at www.raspberryshake.org.

Figure 15. Overview of how a Raspberry Shake seismometer works. (Source of the images: https://raspberryshake.org/curriculum; 17/07/2025)

3.1 Raspberry Shake school network in Switzerland

As part of the seismo@school programme, we have equipped numerous high schools and cantonal schools in Switzerland with a Raspberry Shake seismometer, which continuously records the Earth's movements. These devices register earthquakes in Switzerland and around the world. The seismic data from more than 2,000 sensors worldwide can be accessed via the Raspberry Shake website[3].

Figure 16. Seismic school network in Switzerland, which was expanded as part of the seismo@school project. Interactive map: sas-viewer.ethz.ch.

Is your school taking part in the seismo@school Switzerland programme? If so, you will find your school's Raspberry Shake seismometer station name in the table on the next page. For the following exercises, you can also select any other Raspberry Shake.

More information
Seismo@school project Switzerland: www.seismo.ethz.ch/en/research-and-teaching/projects/seismo-at-school/

[3] https://stationview.raspberryshake.org

Station	Location
RA652	CO d'**Anniviers**
S7A06	Ecole de l'**Arpille**
RB15C	CO **Ayent**
R65E9	EPS de **Begnins** - L'Esplanade
R0CD2	EPS **Bergières**
S8C09	Gymnasium **Biel-Seeland Biel**
RB22F	Cantonal school **Chur**
R8710	EPS **Ecublens**
R5BF0	Collège/EPS de l'**Elysée**
RD3C4	Cantonal School **Enge** Zurich
R3B57	EPS **Grandson**
RB289	CO **Hérens**
RE5E7	Cantonal School **Hottingen** Zurich
RC23B	**Küsnacht** Cantonal School
RC676	Espace des Inventions **Lausanne**
R8E4D	ES de **La Sarraz** et environs
R3BDC	Collège du **Léman**
RE4DE	EPS **Les Ormonts-Leysin**
RA7C7	CO **Leytron**
RE4EF	CO des **Liddes**
RDFB5	High school **Liestal**

Station	Location
R5D35	ES **Nyon-Marens**
R19BB	Gymnasium **Oberaargau**
RDFB5	Gymnasium **Oberwil**
S3900	CO **Orsières**
R46E5	ES du **Pays-d'Enhaut**
RA83F	CO des **Perraires**
R7DBB	**Rämibühl** Mathematics and Science Grammar School
R58D2	**Romanshorn** Cantonal School
RF726	**Rychenberg** Cantonal School, Winterthur
R2D50	CO **Savièse**
R05D6	**Sion** CPPS HES-SO
RFE6B	Cantonal school **Solothurn**
R103E	Cantonal school **St. Gallen**
R7694	CO **St-Guérin**
R1F5E	ES **St-Imier**
R52F7	ES des **Trois-Sapins**
R4335	Gymnasium **Unterstrass**
R8F49	Cantonal school **Uri**
RF727	EPSCL Collège du **Verney**
R4AF0	Cantonal school **Wattwil**
RF726	Zurich Oberland Cantonal School, **Wetzikon**
R3BE0	Cantonal school **Zug**

3.2 Station map and real-time data

With just a few clicks, you can access real-time data from any Raspberry Shake station.

- Go to the interactive Raspberry Shake station map: https://stationview.raspberryshake.org.
- The map shows all publicly accessible Raspberry Shake stations worldwide.
- Click on "**Stations**" in the menu and enter the station name of any station from the table above (e.g. R8710)
- Click on the station name to display the recorded data. On the right-hand side of the browser window, you can see the recordings of the selected Raspberry Shake station, almost in real time.

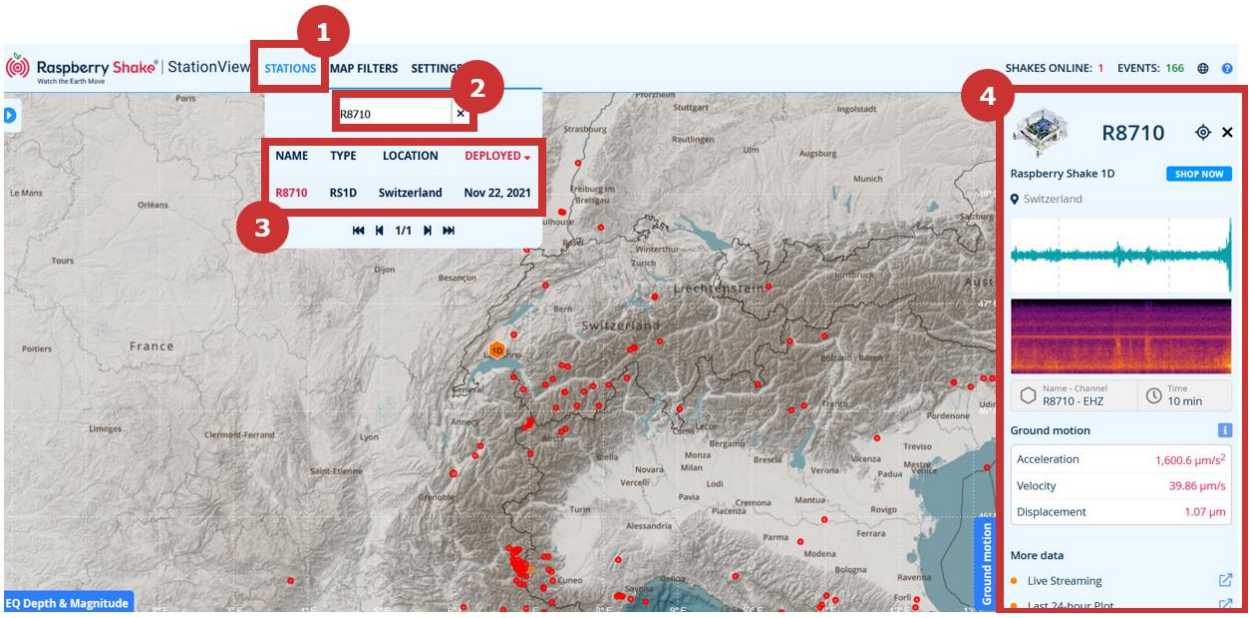


Figure 17. How to access the real-time data of a Raspberry Shake seismometer via the station map: https://stationview.raspberryshake.org. The stations have different symbols: "3D" seismometers record all 3 directions (1 vertical, 2 horizontal) of ground motion. "1D" seismometers only measure the vertical (i.e. up and down) motion.

3.3 Seismogram, spectrogram and frequency

To view the recordings in an enlarged view, click on the symbol next to "**Live Streaming**". A new tab will now open in the browser (Figure 18).

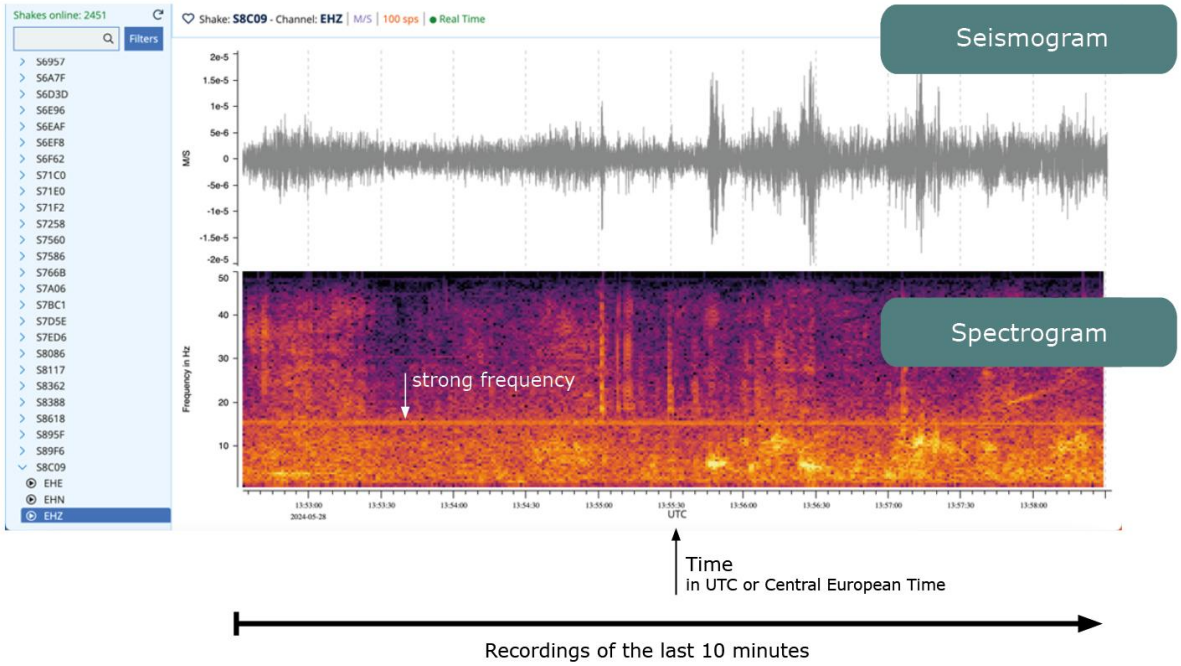


Figure 18. Live streaming of station S8C09 in the web browser. The seismogram is shown at the top and the spectrogram below. The time axis (here UTC – Coordinated Universal Time) runs from left to right. On the left side you can see a list of all available Raspberry Shakes.

The upper part of the website shows the **seismogram**, the lower part the **spectrogram**. These two representations show how the **ground motion** and their **frequencies** change over time. The time axis runs from left to right. By clicking on the time, you can choose between UTC (Coordinated Universal Time) and Central European Summer/Wintertime (as in Switzerland).

Frequency refers to the number of ground vibrations per second. The faster the ground moves up and down or back and forth, the higher the frequency. In a spectrogram, particularly strong or sustained frequencies are highlighted in bright colours.

In the example shown in Figure 18, frequencies of around 15 hertz (Hz) were continuously excited between 13:52:30 and 13:58:30. This is clearly visible as a horizontal line in the spectrogram. A frequency of 15 Hz means that the ground oscillates back and forth 15 times per second.

3.4 Heliplot – the 24-hour seismogram

A so-called **heliplot** displays recorded ground motions over an extended period. As shown in Figure 19, each line from left to right represents 30 minutes of data, with the lines stacked from top to bottom to cover the last 24 hours.

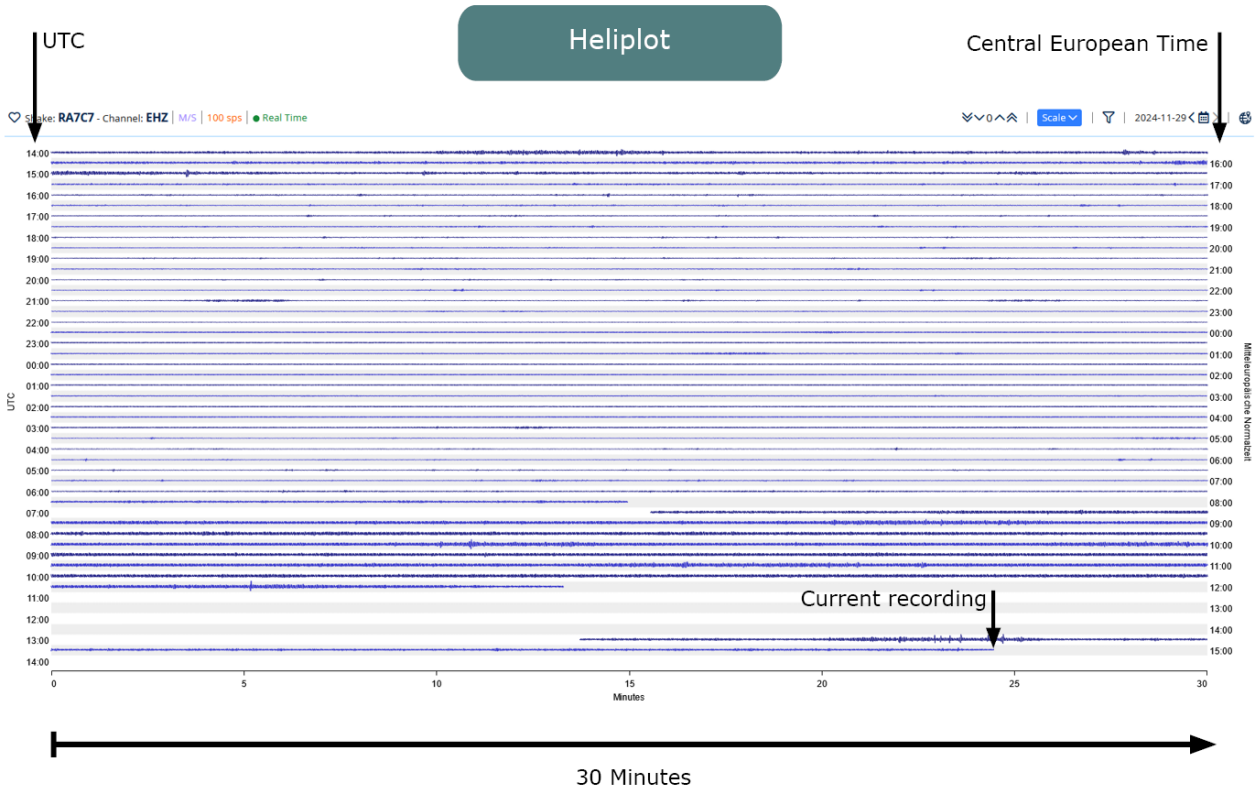


Figure 19. Heliplot (24-hour seismogram) of station RA7C7 on 29 November 2024.

1. In the live streaming of the selected station, click on the icon in the top right corner.
2. You will now see an overview of all recordings (seismograms) from the last 24 hours of the Raspberry Shake, as shown in the example inFigure 19.

To orient yourself, use the time axis on the right-hand side of the heliplot, which displays time in Central European Summer/Wintertime – corresponding to local time in Switzerland. You can click anywhere on the heliplot to enlarge the selected section at the top. Use your scroll wheel or touchpad to zoom in and out.

Task 2: Live seismogram, spectrogram and heliplot

Take a close look at the live seismogram and spectrogram from any Raspberry Shake. You may choose a station from the Raspberry Shake school network in Switzerland (see table above).

1. Describe what you notice. Take one or more screenshots.
2. What could have caused the ground motions recorded by the Raspberry Shake? If you are close to the Raspberry Shake, you can jump up and see if the vibrations are recorded. (Attention: There is a small delay before you can see your jump in the live streaming. If the vibrations are too strong, the amplitudes may "clip", i.e., the measured values will exceed the maximum measuring range, and the movement will no longer be displayed correctly.)

Solutions task 2: Live seismogram, spectrogram and heliplots

Seismometers record not only ground motion from earthquakes, but also vibrations caused by human activity, traffic, machinery, or natural influences such as the weather. From a seismological perspective, such signals are considered noise.

Long-lasting or repetitive signals that affect only a narrow range of frequencies – visible as horizontal lines in the spectrogram – are often indicative of this type of background noise.

Seismometers in official monitoring networks are generally not installed in areas with heavy traffic or other sources of disturbance. They are typically placed in underground shafts, where they are as well insulated as possible from seismic noise. This enables them to focus on their primary task: recording seismic waves.

Task 3: Recognising earthquakes

Figure 20 and Figure 21 show two heliplots recorded by a Raspberry Shake in Switzerland on 1 January 2024 and 27 February 2024.

An earthquake is "hidden" in both heliplots.

1. Do you recognise the earthquake?
2. How do the records of these two earthquakes differ?

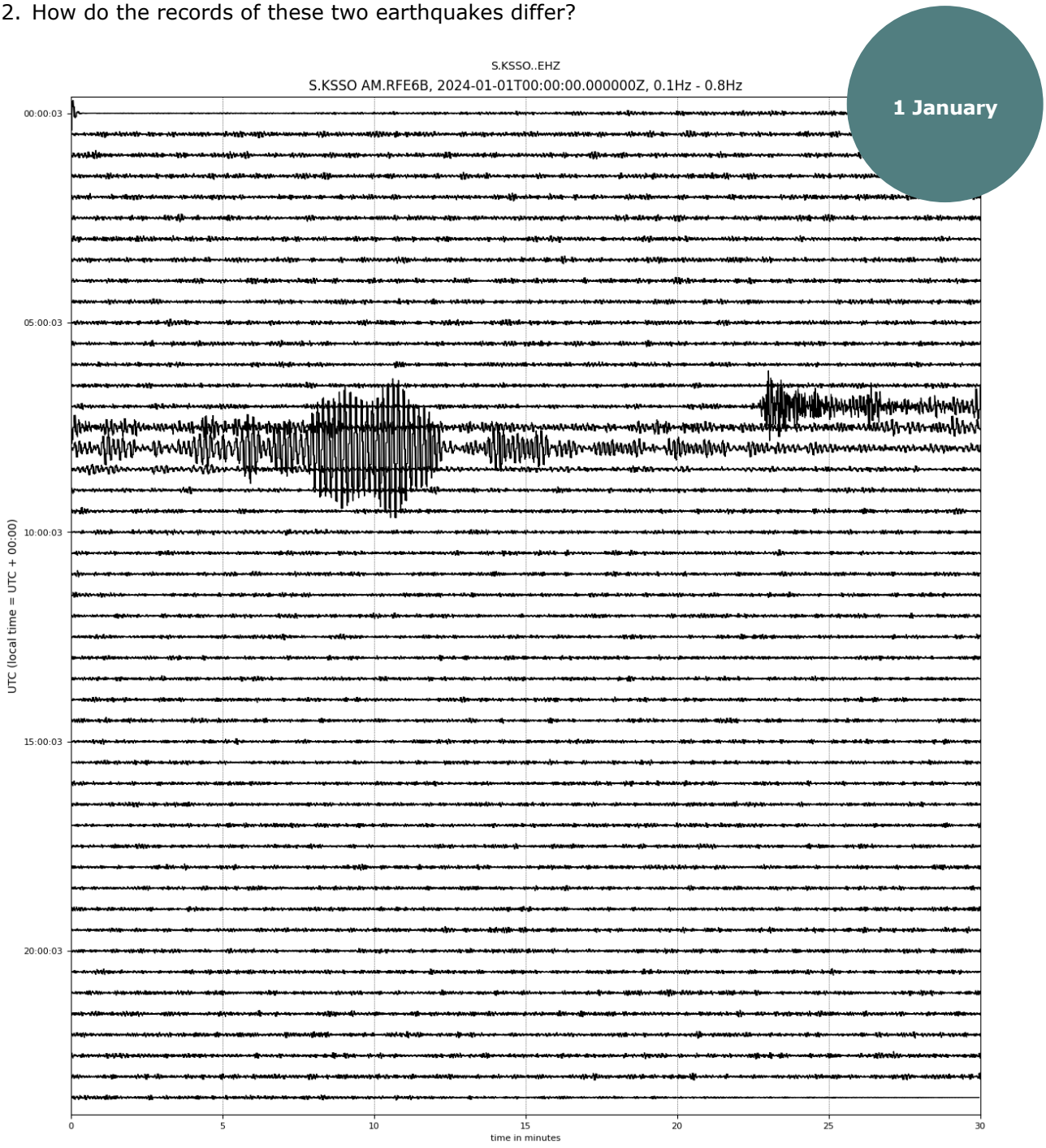


Figure 20. Heliplot from 1 January 2024 of the Raspberry Shake RFE6B at the Solothurn Cantonal School (KSSO).

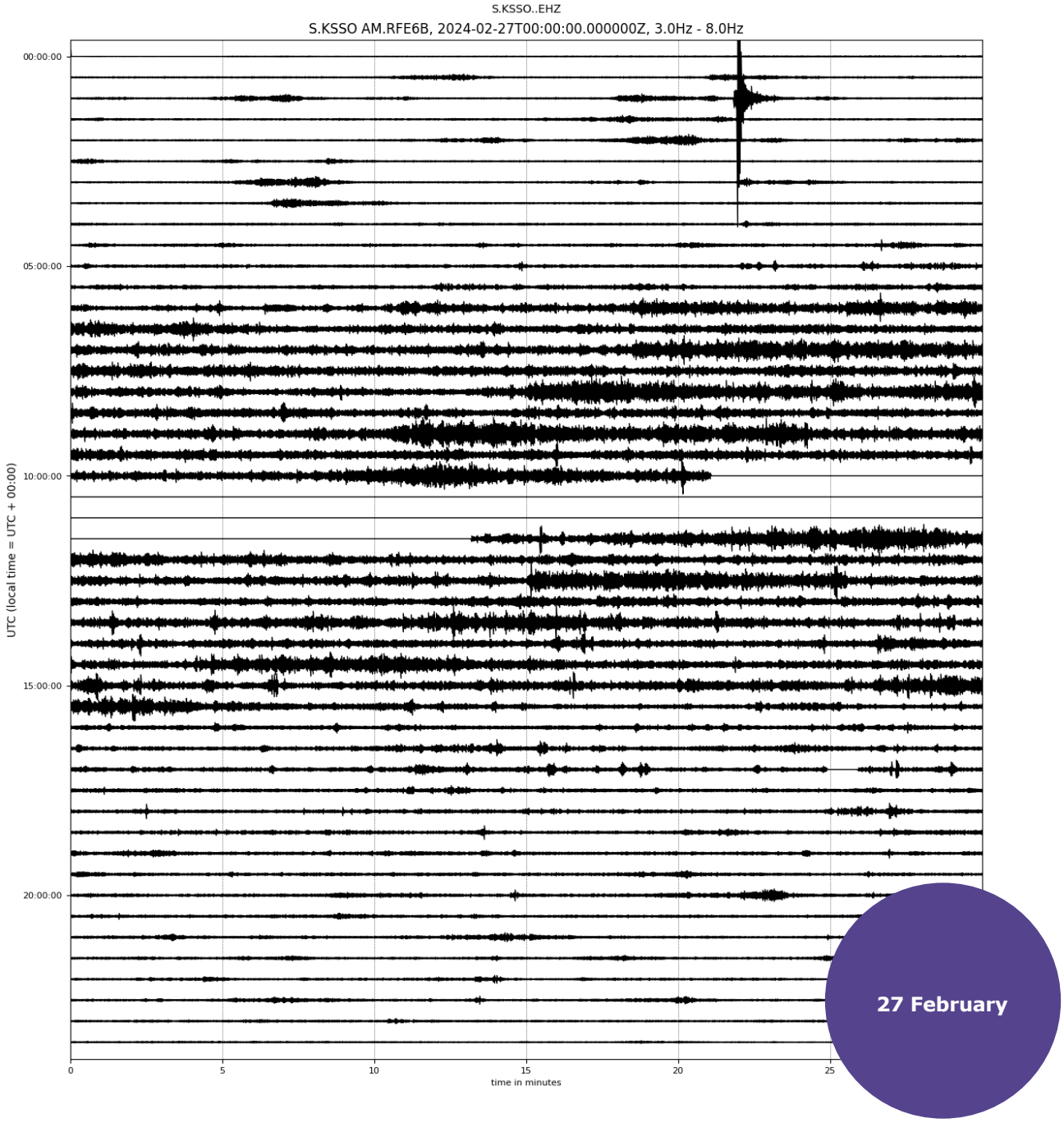
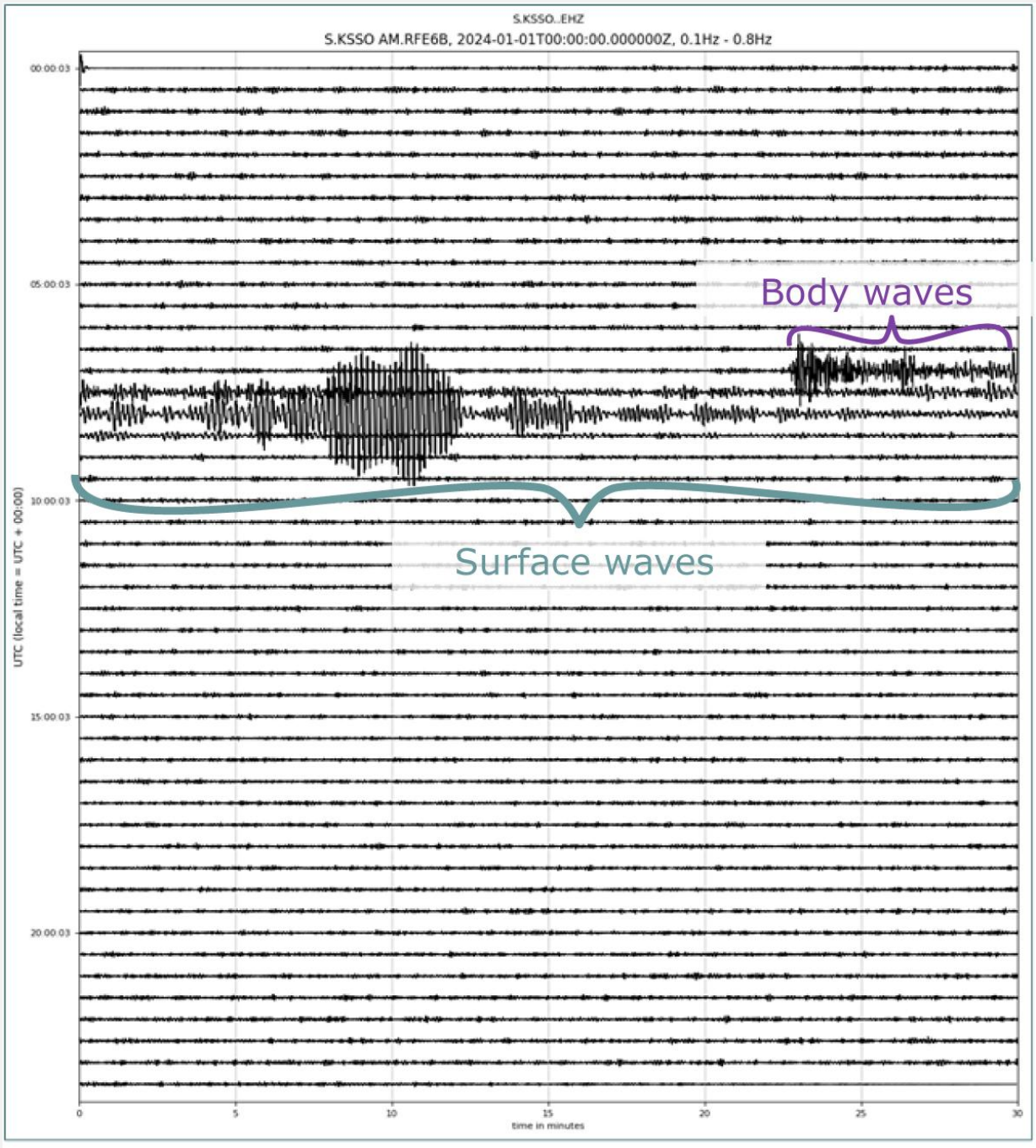


Figure 21. Heliplot of the Raspberry Shake RFE6B at the Solothurn Cantonal School (KSSO) on 27 February 2024.

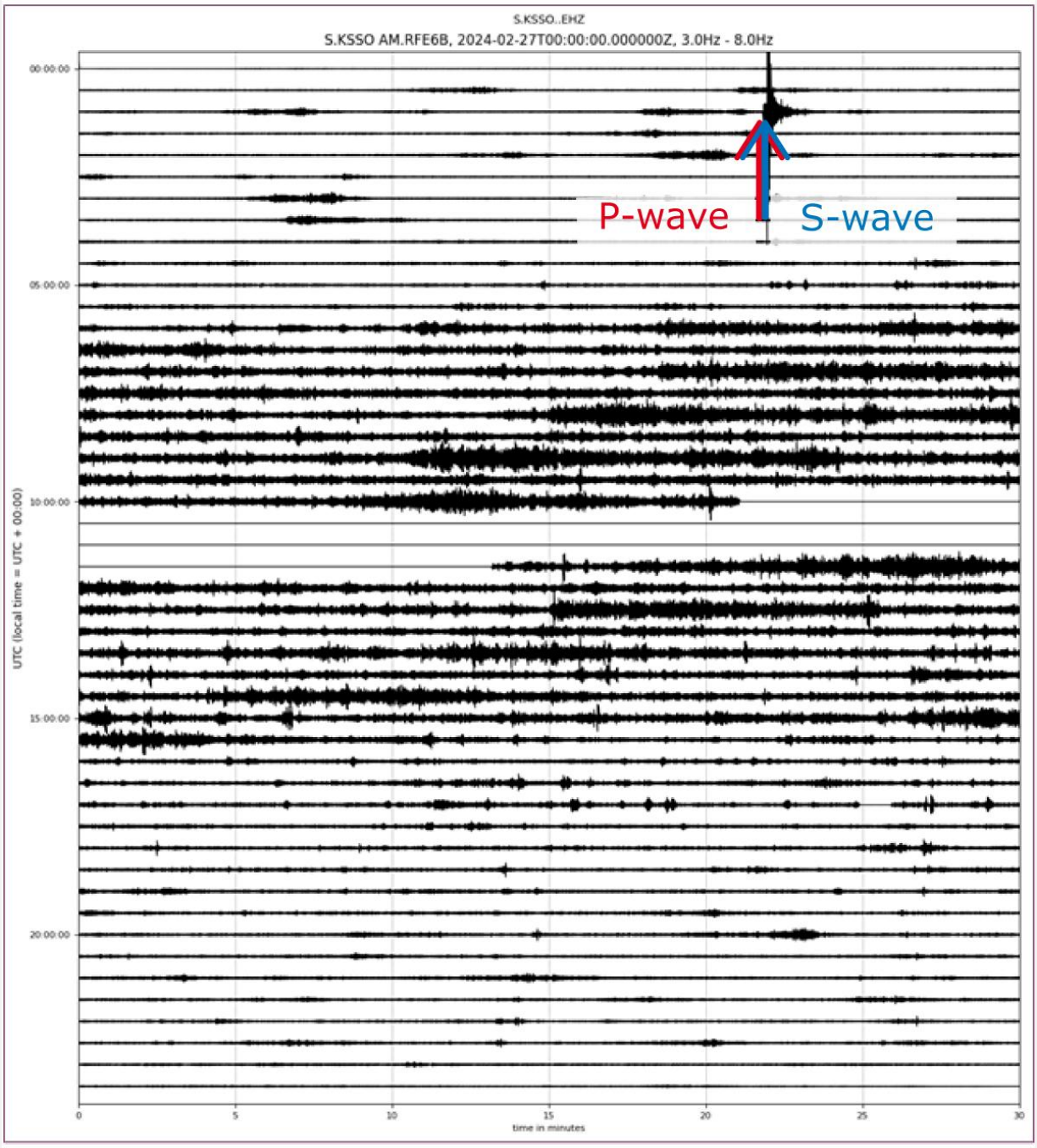
Solution task 3: Recognising earthquakes

Earthquake with a magnitude of 7.5 in Japan on 1 January 2024

Body waves = P and S waves
Surface waves = Love and Rayleigh waves



Earthquake with a magnitude of 3.4 near Porrentruy (canton of Jura) on 27 February 2024



The seismograms of the two earthquakes differ primarily in their signal duration and frequency range:

- The earthquake in **Japan** (around 10,000 kilometres from the station) was recorded over several hours. Seismic waves travel through different geological layers where they are reflected and refracted, propagating at varying speeds. This influences the duration and complexity of the signal. The different types of waves are clearly visible: The body waves (P and S waves) arrive at the station first, followed much later by the surface waves.
- The recording of the local earthquake in **Switzerland**, which occurred around 46 kilometres from the station, is only a few seconds long. It has significantly higher frequencies, up to around 20 Hz. The P- and S-waves can be seen clearly in this seismogram, and their arrival times are barely distinguishable.

3.5 Seismic noise

Seismic stations record all types of ground motion, not just earthquakes. However, these recordings are dominated by so-called **seismic noise**, which is generated by vibrations from distant sea waves, atmospheric pressure changes, or human activities such as quarry blasting, traffic, construction, and explosions. This background noise can be used to map the subsurface or to estimate how much seismic waves are amplified by local ground conditions.

A closer look at the data can sometimes reveal events with a seismic signature. These include natural phenomena such as landslides, as well as human-made sources like railway traffic, sonic booms, or large concerts and football matches – whenever many people move rhythmically at the same time.

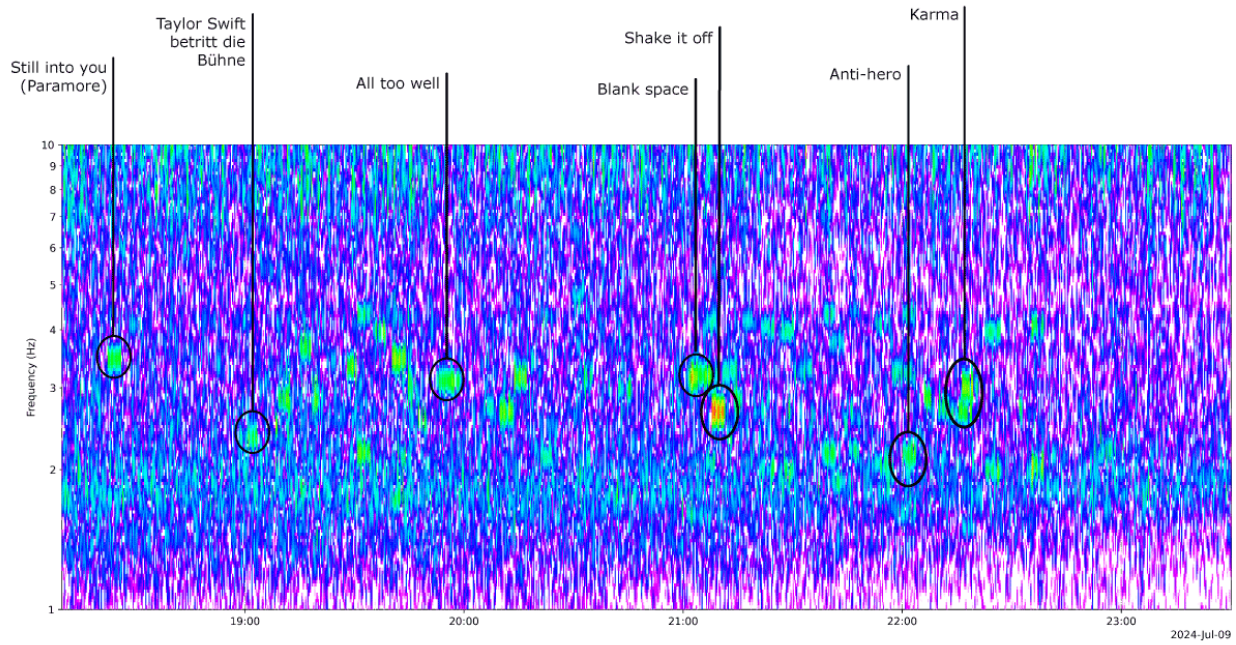


Figure 22. Recorded ground shaking from the Taylor Swift concert in Zurich in July 2024 as a spectrogram.

Task 4: Can you recognise what it is?

In addition to earthquakes, our Raspberry Shake seismometer has also recorded many other tremors. Can you recognise what it is from the seismograms and spectrograms?

To the quiz

Link to the quiz: https://forms.office.com/e/RpjwruggiE

4. Jupyter Notebook "Raspberry Shake Switzerland"

With the help of the web application "Jupyter Notebook Raspberry Shake Switzerland" you can access the data of all Raspberry Shakes in the Swiss school network.

If you already have experience with Python programming, you can modify or extend the code. Otherwise, you can use the application in a simplified mode as described below.

Open **Jupyter Notebook Raspberry Shake Switzerland** in your web browser: https://mybinder.org/v2/gh/maboese/seismo_at_school/master

Loading may take a moment, please be patient. Various notebooks (.ppynb) are available on the left-hand side of the browser window.

1. Double-click on **seismograms.ipynb**
2. Click on "**Run**" in the top menu and then on "**Run All Cells**".
3. After a few seconds, a menu appears.

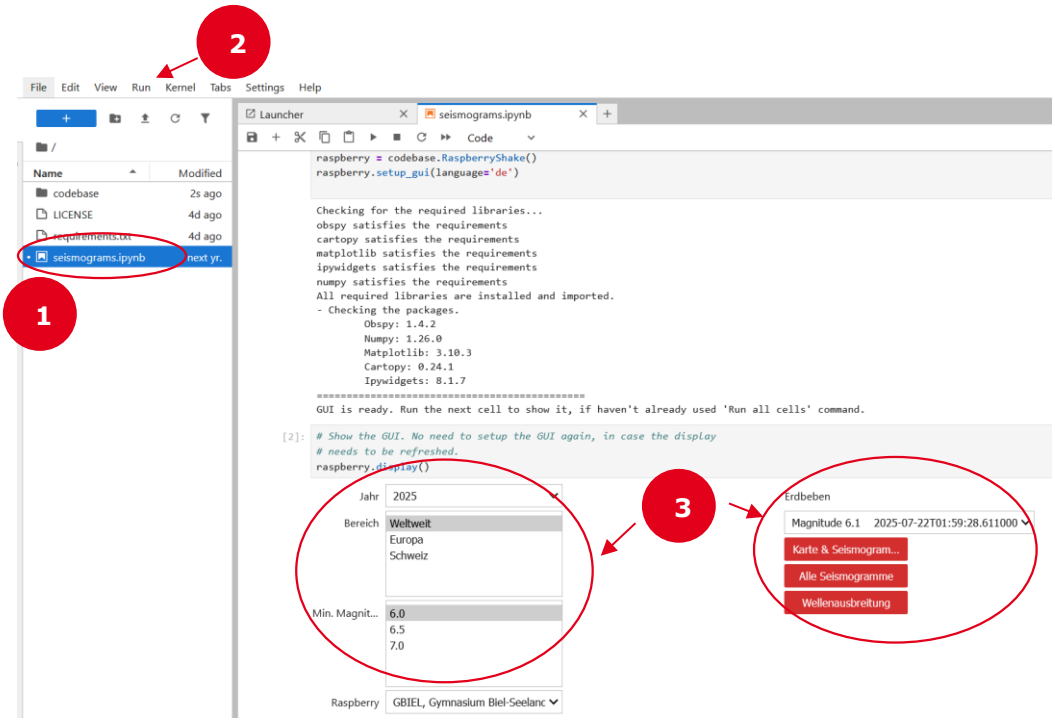
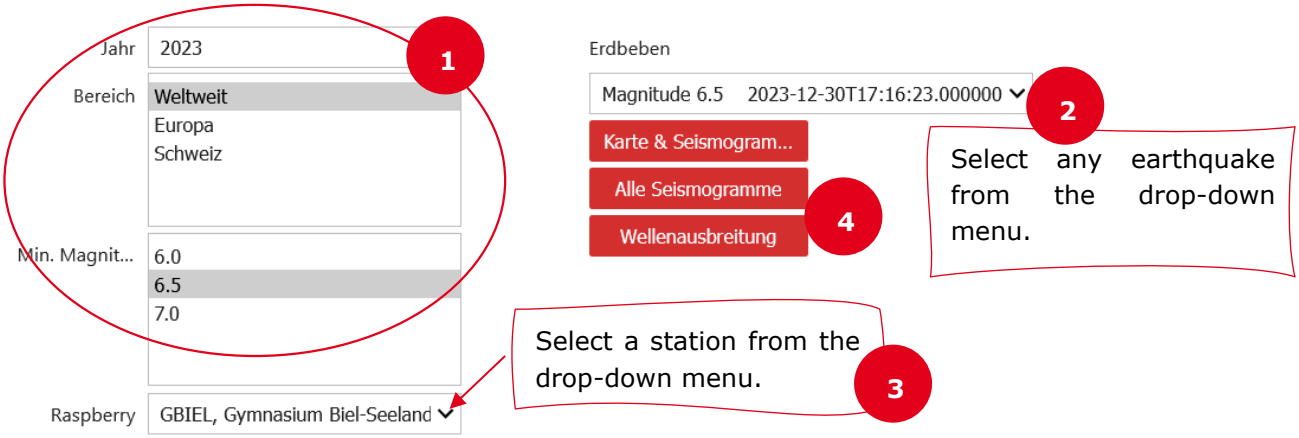
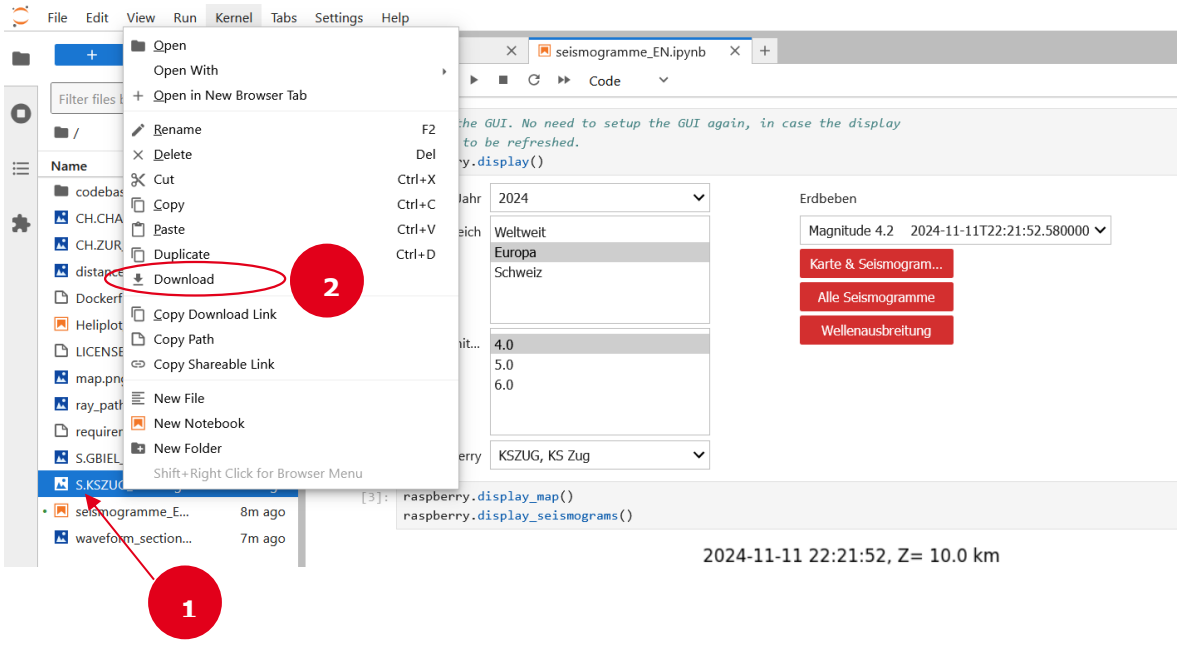


Figure 23. Screenshot of the Jupyter notebook.

1. On the left-hand side of the menu, you can now select a year ("Jahr"), a region ("Bereich") and a minimum magnitude ("Min. Magnitude"). On the right-hand side, under "Erdbeben", you can see which earthquakes are found in each case.



2. Select an earthquake.
3. Select a "Raspberry Shake" on the left-hand side.
4. Click on "Karte & Seismogramme" to display a map and the seismograms. To see the seismograms from all Raspberry Shakes, click on "Alle Seismogramme". *Please note that it can take a few seconds for the map and seismograms to appear, as the data needs to be downloaded from the server.*
5. The maps and seismograms are automatically saved as ".png" files. You can download the files in the list on the left by right-clicking and selecting "Download".



Task 5: Working with the Jupyter notebook

1. Analyse earthquakes

Adjust the search parameters to answer the following two questions:

– What was the strongest earthquake **worldwide** in 2024 (Use the parameter "weltweit").
– What was the strongest earthquake in **Switzerland** in 2024 (Use the parameter "Schweiz")?

2. Bonus task for fast learners

Select any Raspberry Shake and run the search by clicking on "Karte & Seismogramm" and "Alle Seismogramme".

Write a short report on your observations of the strongest in Switzerland and worldwide.
– Include the illustrations (maps, seismograms)

Try to answer the following questions:
– How do the seismograms of the two earthquakes differ in terms of duration and frequency?
– Can you identify the P-and S-waves?
– How do the P- and S-wave arrivals recorded for the local earthquake in Switzerland differ from those of the distant earthquake? Can you explain the differences?
– Based on the time difference between the P- and S-wave arrivals, can you estimate the distance to the local earthquake?

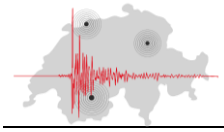
Solutions Task 5: Working with the Jupyter notebook

- Strongest quake worldwide in 2024: Magnitude 7.5 on 1 January 2024 in Japan
- Strongest quake in Switzerland in 2024: Magnitude 4.4 on 4 June 2024 at Pragelpass GL/SZ

Additional task for fast learners: individual solutions.

Further teaching material

Would you like to know more about earthquakes? You can find out more here:



Earthquakes - basics and the most important concepts
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Misinformation and media literacy
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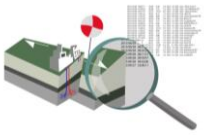
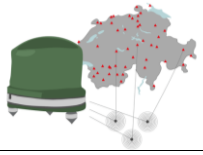
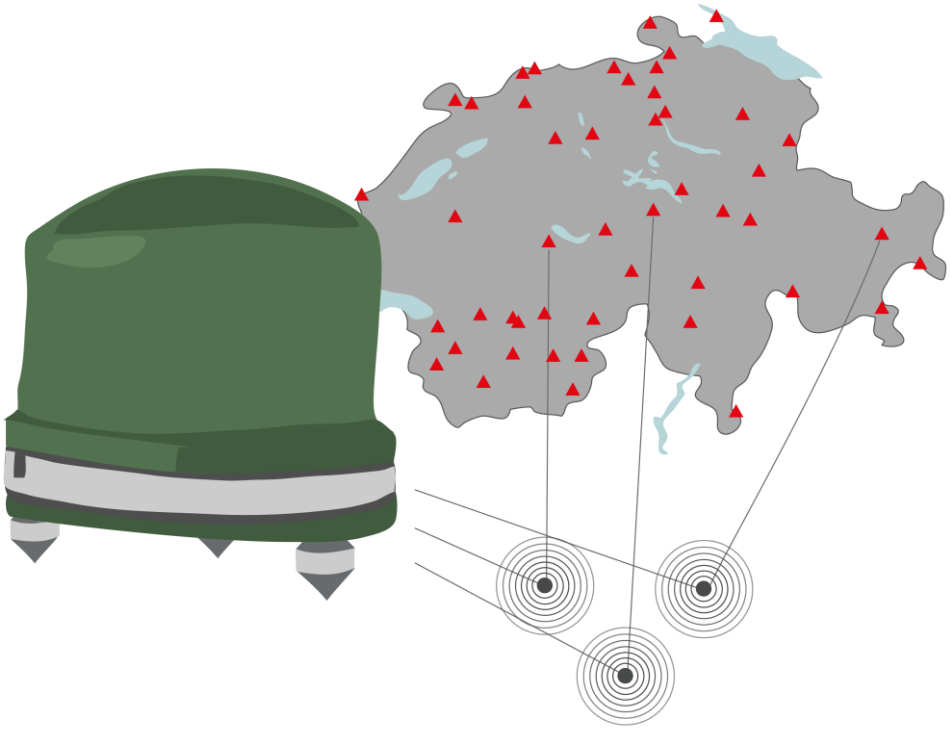


Induced seismicity
Download



Earthquake monitoring and Raspberry Shake
Download

Further information on earthquakes can be found on the website of the Swiss Seismological Service at ETH Zurich at

We are happy to receive questions and suggestions on the learning modules or other topics relating to earthquake teaching in schools.

e-mail: seismo_at_school@sed.ethz.ch