

THE CHARLEVOIX-KAMOURASKA EARTHQUAKE OF 1925



THE EARTHQUAKE

Description
On February 28, 1925 at 9:19 p.m., an earthquake of magnitude 6.2 on the Richter scale struck the Charlevoix-Kamouraska area. It was felt more than 1000 km from the epicentre under the St. Lawrence River. In the following weeks, dozens of aftershocks continued to shake the area, keeping residents on high alert.

Damage was reported in the epicentral zone, as well as in the cities of Québec and Shawinigan. Chimneys and masonry buildings were particularly sensitive to the ground vibrations.

The map at right shows the estimated position of the 1925 earthquake's epicentre (red ellipse) and the epicentres of the approximately 2000 earthquakes recorded between 1978 and 2012. The semicircle of the Charlevoix meteorite impact crater is clearly visible on this image where topography is shown using colours that range from blue for the lowest elevations to red for the highest ones. Since 1978, earthquakes have been monitored by a network of seven seismographs (white triangles).

Which fault?
Analysis of the seismograms showed the orientation of the fault that was reactivated by the earthquake (red line on the block diagram at right), which suggests that the fault was parallel to the St. Lawrence River. It is believed that the southeast block was thrust over the northwest block at a depth of 10 km below the surface (see cross-section at right).

Logan's Line, which is shown on the cross-section, marks the position of the Appalachian Front. It intersects the Earth's surface under the St. Lawrence River, close to its northern bank. Contrary to popular belief, this very ancient fault is not active: all earthquakes occur well below it in the Canadian Shield, as the cross-section shows.

Most earthquakes in eastern Canada are caused by nearly horizontal compression forces that lift enormous blocks of rock.

Depth of the Charlevoix earthquakes
In Charlevoix, earthquakes occur in the Canadian Shield at depths of up to 30 km. The 1925 earthquake occurred at a depth of approximately 10 km, the average for earthquakes in the area. For the sake of comparison, the maximum depth of the St. Lawrence River is only 150 m in Charlevoix.

Seismograms
The main shock was recorded by 30 seismograph stations worldwide.

The evening of the main shock, seismologist E.A. Hodgson was able to locate the epicentre near the mouth of the Saguenay River using the records from the Ottawa seismograph (see figure at right). He first deduced the azimuth from the relative amplitudes on the north-south and east-west components; then he calculated the epicentral distance from the difference in arrival times between the P- and S-waves. He was able to tell the press about the epicentre the very same evening!

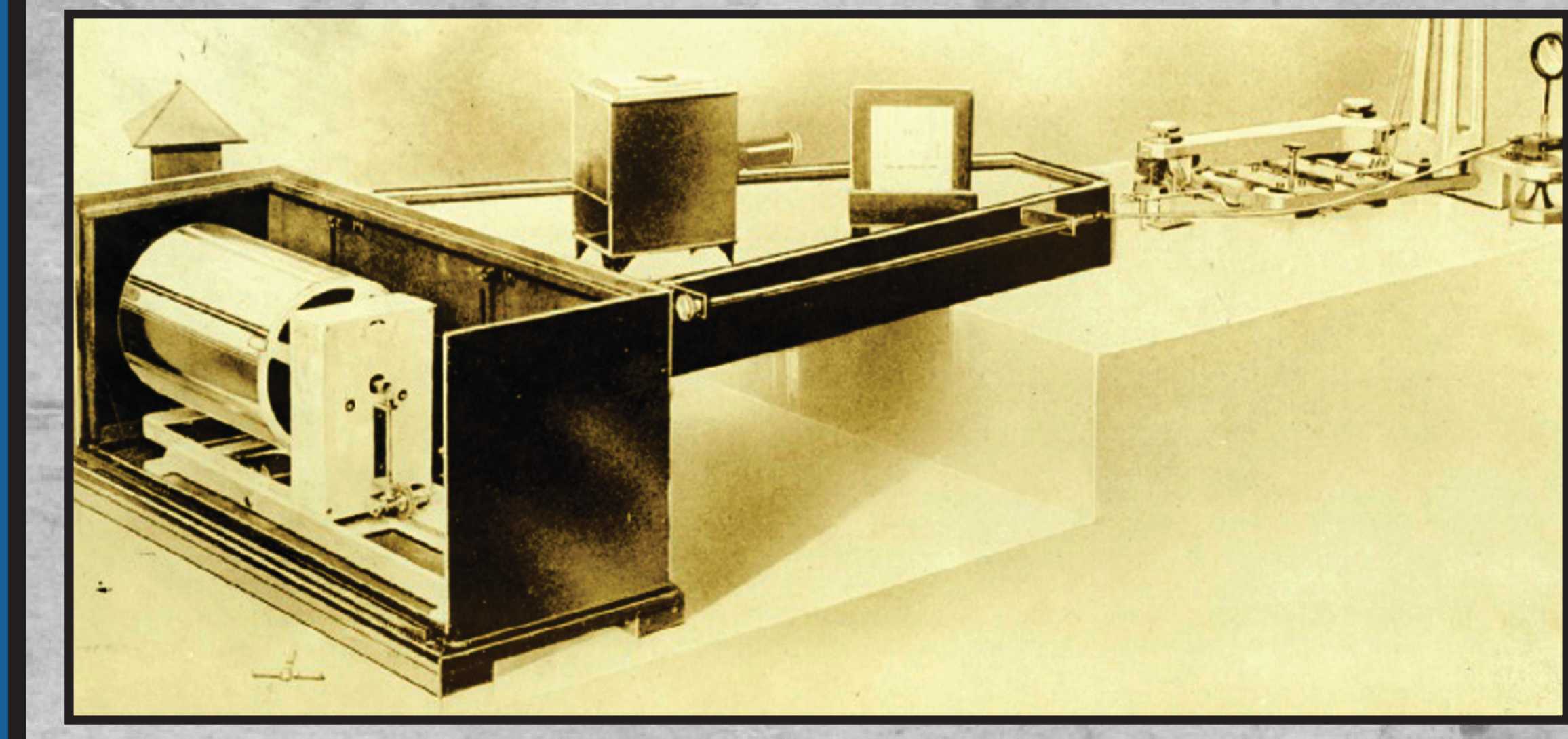
The epicentre location in Charlevoix-Kamouraska was confirmed by the analysis of the arrival times of seismic waves recorded on five other seismograph stations across Canada.

Field studies conducted by E.A. Hodgson in the months following the main shock confirmed the location of the epicentre, which was near the island of Île aux Lièvres, an area where several earthquakes with magnitudes of 4.0 and higher occurred in the 20th century.

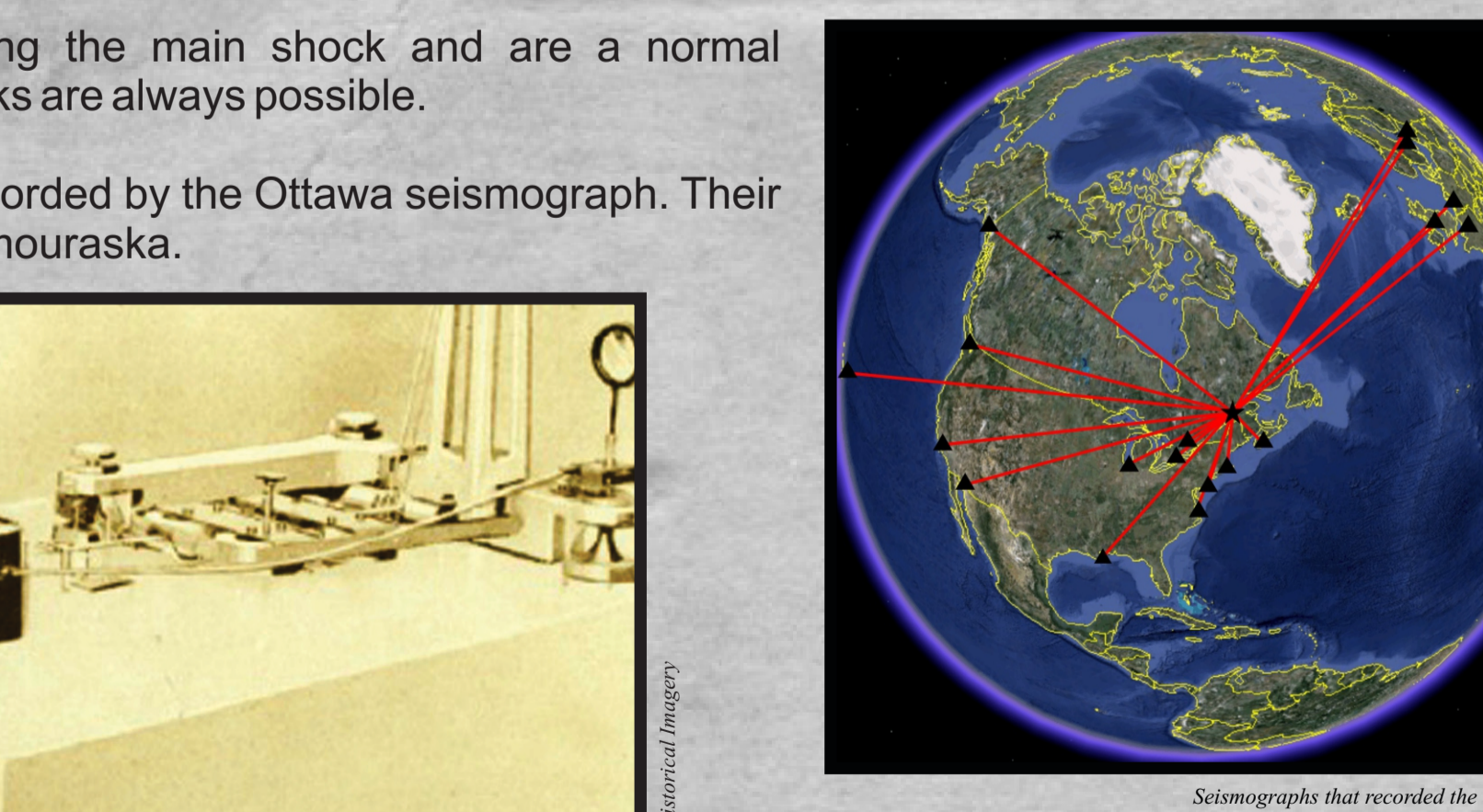
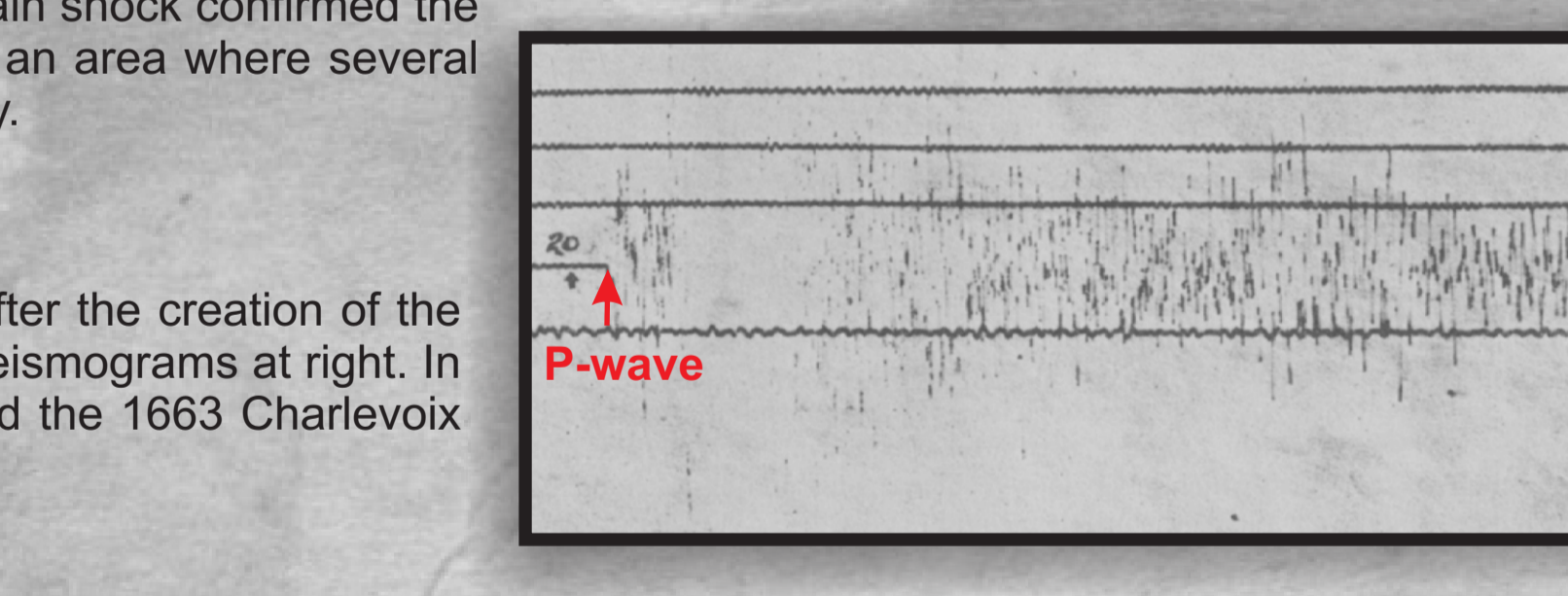
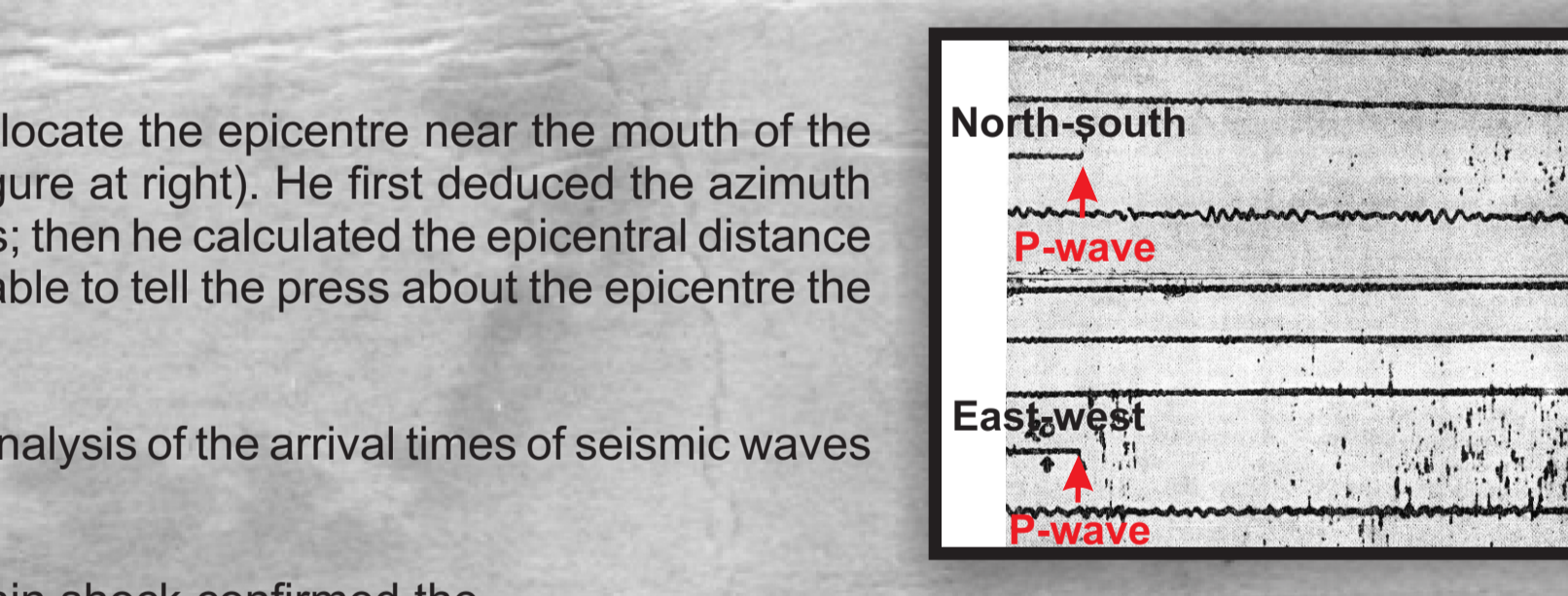
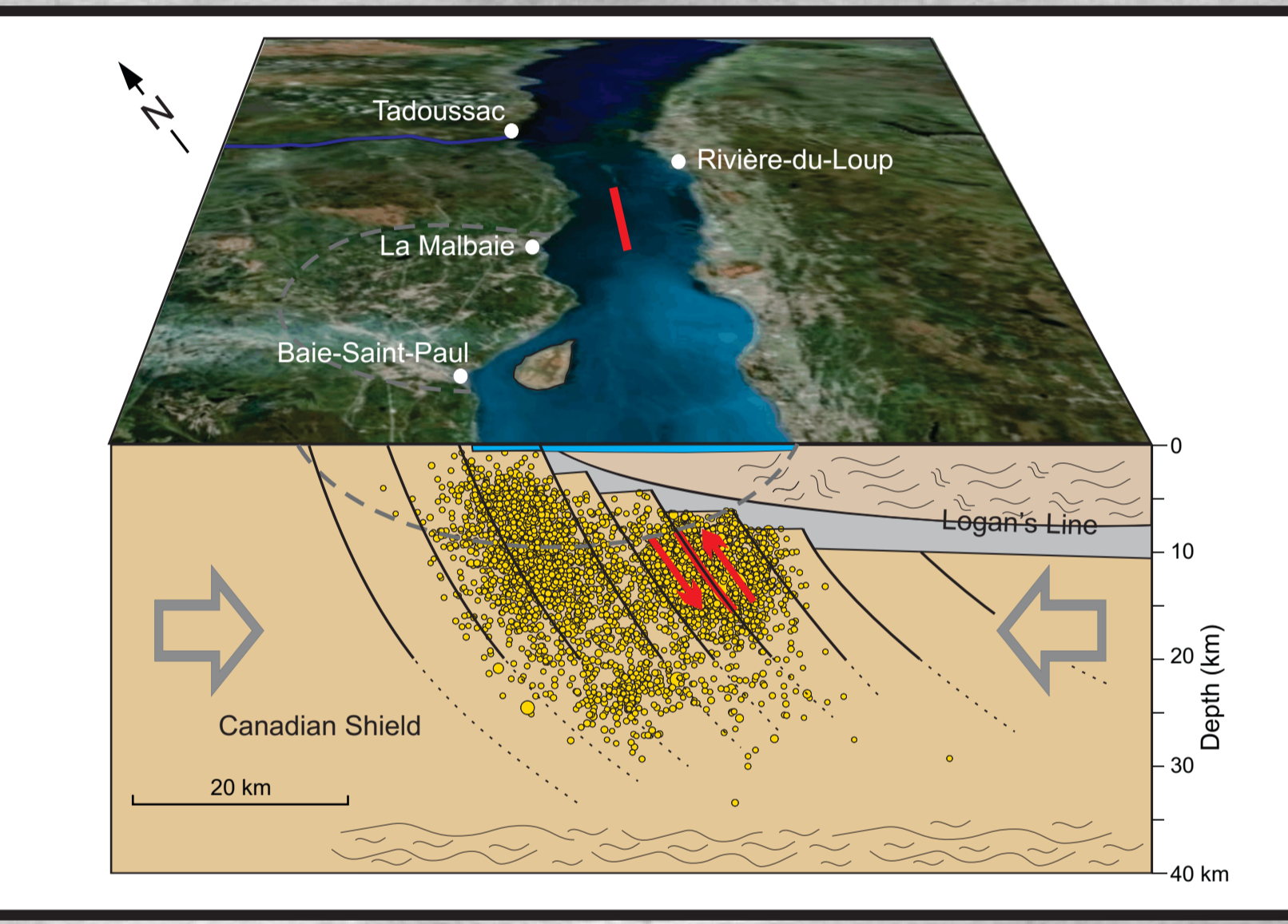
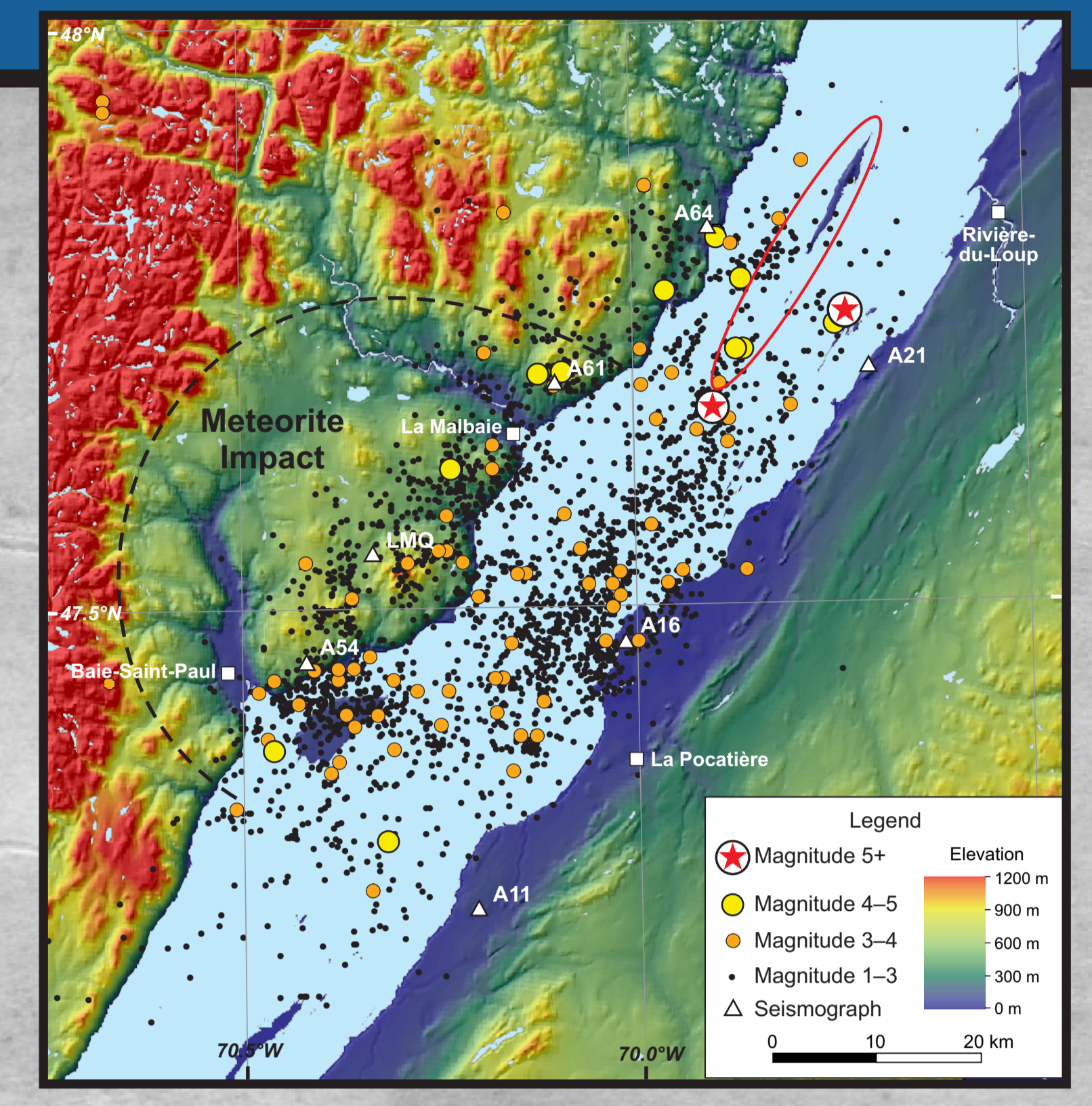
What was the magnitude of the earthquake?
The 6.2 magnitude of the 1925 earthquake could only be established after the creation of the Richter scale in 1935. The magnitude was initially calculated using the seismograms at right. In comparison, the 1988 Saguenay earthquake was a 5.9 on the scale and the 1663 Charlevoix earthquake was a 7.

Aftershocks
Aftershocks result from the readjustment of the Earth's crust following the main shock and are a normal phenomenon. The frequency of aftershocks diminishes over time, but shocks are always possible.

The strongest aftershocks in the month following the main shock were recorded by the Ottawa seismograph. Their magnitudes varied from 3.7 to 5, and they were all felt in Charlevoix and Kamouraska.

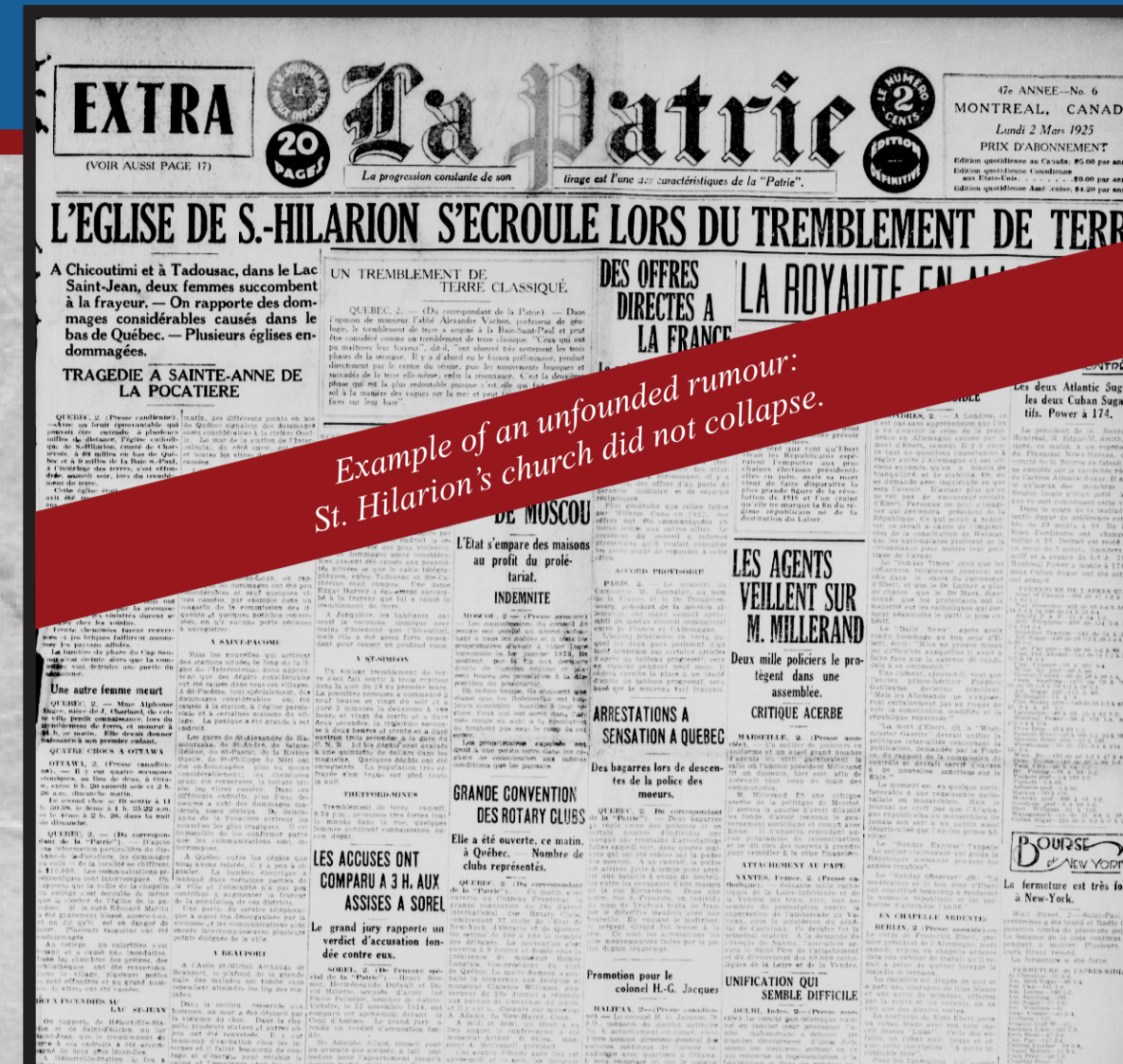


A seismograph of the same type as shown in operation at the Dominion Observatory at Ottawa in 1925



Seismographs that recorded the earthquake

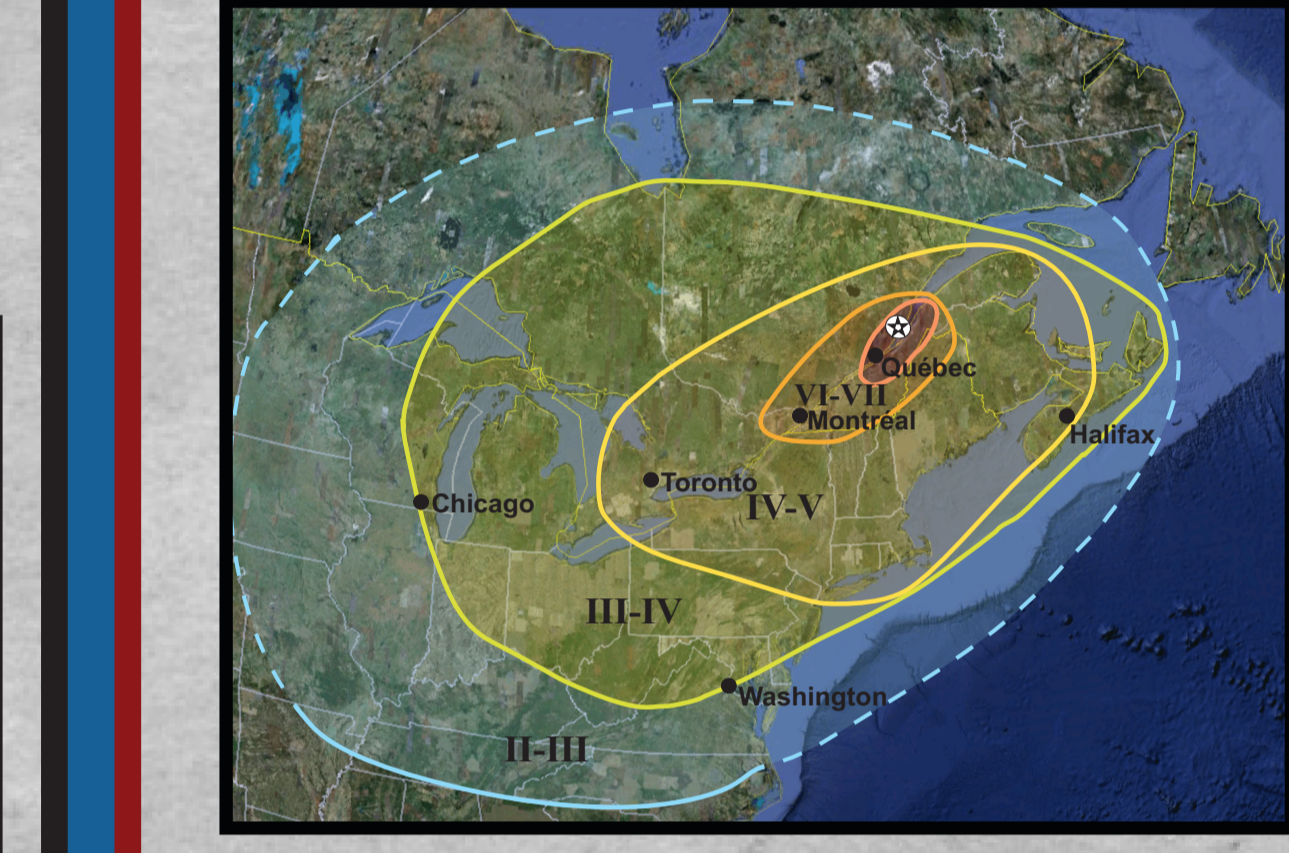
EFFECTS



What did the newspapers report?

According to the papers (alarmist at times) and eyewitness accounts, the earthquake had a major impact on the local population on both sides of the St. Lawrence River.

Mercaalli intensity scale: how the earthquake feels



- VIII:** Fright general — alarm approaches panic. Fall of chimneys, columns, monuments. Damaged walls. Heavy furniture overturned. Damage considerable.
- VI-VII:** General alarm, all run outside. Some cracked chimneys and walls, broken windows. Fall of plaster in considerable to large amount.
- IV-V:** Felt indoors by practically all, outdoors by many or most. Overturned small or unstable objects, in many instances, with occasional fall.
- III-IV:** Felt indoors by several, motion usually rapid vibration. Hanging objects may swing slightly.
- II-III:** Felt indoors by a few people, especially on upper floors.

Charlevoix (north shore) — The following is seismologist E.A. Hodgson's description during his visit after the earthquake.

Baie-Saint-Paul: Because the town is built on the unconsolidated deposits of the Rivière du Gouffre valley, minor damage was widespread, including broken windows, fallen chimneys, broken dishes. Two bells from the 45 m tower of the stone church came off their axle and a cubic metre of stone was dislodged from the bell tower.

Saint-Urbain: Broken windows and fallen chimneys were common, though houses of wood-frame construction were otherwise unharmed. The stone church which had survived the earthquake of 1870 was practically destroyed. The spire was dangerously tilted towards the northeast and finally fell in the middle of the night, 11 days after the earthquake (March 11).

Les Éboulements: Cracked plaster and fallen chimneys were common. In several cases, the walls of stone houses were cracked.

Pointe-au-Pic: Because foundations here were built on rock, the damage was relatively minor. Most chimneys were damaged, fireplace masonry was cracked, and some statues moved or fell. The main shock was felt by the crew on a train approaching Pointe-au-Pic.

La Malbaie: This municipality is built partly on rock and partly on the sediments at the mouth of the river. The courthouse, a massive stone building constructed on unconsolidated deposits, was badly cracked throughout. The church, which was built on solid rock, was not damaged. Several stoves moved but no fires resulted. Many chimneys fell.



Trois-Rivières and Shawinigan: In Trois-Rivières, only the masonry of industrial buildings was damaged. In Shawinigan, damage to houses and to a masonry church built on the clay portions of the city was reported.



Québec: Residents of the area of the city of Québec felt the earthquake quite distinctly. Most of the damage was to large buildings, such as churches, hospitals, the train station, and grain elevators, particularly in the city's lower town and port, where buildings were constructed on unconsolidated deposits or fill.

IMPACT OF THE EARTHQUAKE

Local population
Though many people would long remember the earthquake, only the local population of Charlevoix and Kamouraska would suffer its traumatic effects.

- The shock experienced by a person after an earthquake can vary according to the following:
- intensity of the vibrations;
 - physical or psychological vulnerability;
 - direct threat perceived;
 - level of knowledge about earthquakes;
 - degree of preparedness.

When trauma is experienced, repeated aftershocks can either sustain or exacerbate it. Many of the residents in the affected area experienced most of the above factors, which made the earthquake a traumatic event.

- For example:
- During the Charlevoix earthquake, the vibrations were so strong that people had difficulty standing.
 - Hardly any information explaining earthquakes was available to reassure the population.
 - Rumours of imminent shocks spread in the days and weeks following the main shock.
 - Aftershocks were felt for weeks.

Although the earthquake did not cause any direct casualties, feelings of insecurity were widespread among the local population. To reassure themselves, people gathered to pray and keep each other company in the evenings. The song shown at right was written by a local nurse. It describes the fright that was felt throughout her hospital after the earthquake.

Seismic significance The 1925 earthquake is one of five earthquakes of magnitude 6 or more to occur in the Charlevoix area since 1663 and one of the strongest in eastern Canada in the 20th century. It was the first major earthquake in Canada to be recorded by seismographs worldwide. It also confirmed that damage is mainly concentrated in the clayey and sandy zones of affected areas. E.A. Hodgson (photo below) was only able to publish his report on the earthquake in 1950 because it was feared that the quake would keep tourists away and harm investment.



Canadian seismologist E.A. Hodgson

Prevention and preparation
The earthquake of 1925 and all other earthquakes felt in the region made it possible to determine the seismic hazard for Charlevoix-Kamouraska, the highest in all of eastern Canada, as illustrated on the map at right.

The National Building Code of Canada standards take seismic hazard into consideration and are regularly updated to ensure public safety. Though rare, earthquakes that cause damage can occur, but they are still impossible to predict. Simple planning and preparation measures can make all the difference in an emergency. Advice on preparing an emergency plan and kit are available at www.getprepared.gc.ca.

Song composed following the earthquake

AUX VAILLEUSES DU 28 FÉVRIER 1925
Tune: 'O Holy Night'

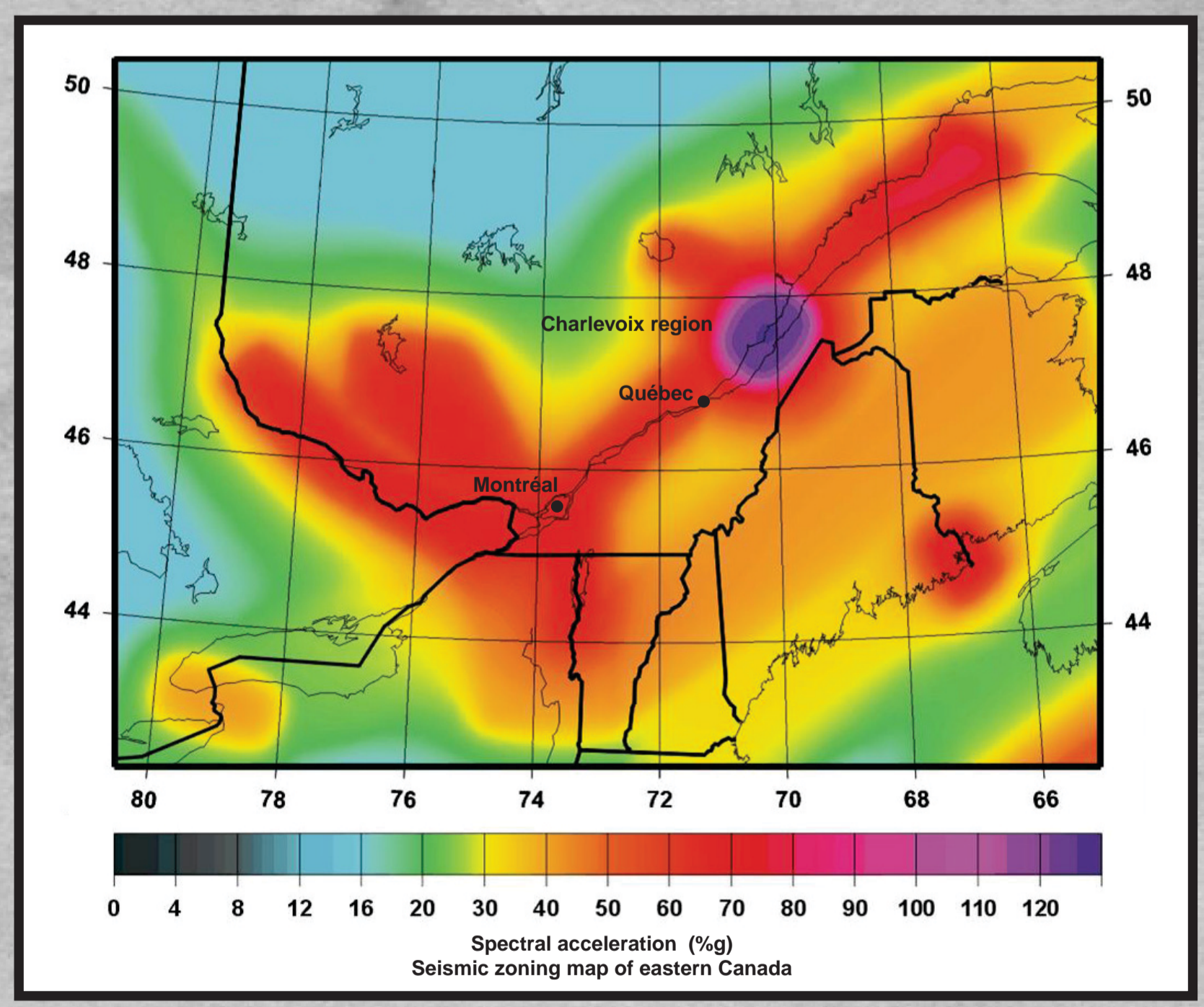
Neuf heures et vingt, c'est l'heure solennelle,
Où sur les basses, notre terre a tremblé;
À l'hôpital, la secousse fut telle,
Que les patients étaient tous affolés,
Ils appelaient, et d'une voix plaintive,
Ils redisaient leur crainte, leur terreur,
Les jeunes gardes, timides mais attentives,
Allaient, venaient, dominant leur frayeur. (bis)

Ce va et vient des secousses sismiques,
Éfraya bien les gens de la maison,
Tous et chacun, en ce moment critique,
Ont bien senti l'acte de contrition,
Tout est passé et le calme succède,
Tout est passé et le calme succède,
À cette angoisse, à ce mortel effroi,
Que dans nos coeurs aussi la crainte cède;
Gardons, gardons notre espoir, notre foi. (bis)

Un bon Abbé à l'âme compatissante,
Veut bien passer par toute la maison,
Sa voix rassure et sa main bénissante,
Sur plus d'un coeur appelle les gardons,
Un Dieu préside à la marche des mondes,
Le prêtre ici est ministre de paix,
Sa main absout, sa parole va, féconde,
Donner, donner la grâce, les bienfaits. (bis)

Seigneur Jésus, entends notre prière,
De tes enfants, elle est le cri du coeur;
Délivre-nous du tremblement de terre,
Nous t'en prions, exauce-nous Seigneur,
Si tu le veux, ô Maître, ta parole,
Raffermira et les faits et les mots;
L'on nous verra, comme en la Décapole,
Benir, bénir exalter ton Saint Nom. (bis)

Source: Canadian Folk Music Bulletin,
Volume 22, no. 1, September 1988



For more information: www.earthquakescanada.nrcan.gc.ca

Compiled and written by Maurice Lamontagne, Geological Survey of Canada

Cette publication est aussi disponible en français.

Recommended citation
Lamontagne, M., 2012. The Charlevoix-Kamouraska earthquake of 1925; Geological Survey of Canada, Popular Geoscience 96, poster, doi:10.4095/291572

Catalogue no.: M41-9/96E-PDF
ISBN 978-1-100-20944-9
doi:10.4095/291572

This publication is available for free download through GEOSCAN (<http://geoscan.ess.nrcan.gc.ca/>).

© Her Majesty the Queen in Right of Canada 2012