

THE EARTHQUAKE OF JULY 14, 1977

OBSERVATIONS OF EFFECTS

by

D.A. Forsyth and J.P.S. Mercure

SEISMOLOGICAL SERVICE OF CANADA

INTERNAL REPORT 77-10

Revised 77/12/15

Division of Seismology and Geothermal Studies

Earth Physics Branch

Department of Energy, Mines and Resources

OTTAWA

November 1977

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

The Earthquake of July 14, 1977

In response to requests for personnel to carry out an isoseismal cum aftershock survey following the event of July 14, 1977 at 03:39 EST, S. Mercure and D. Forsyth left Ottawa by truck at 11:00 hrs. Since the epicentre was estimated to be about 10 km southwest of Ste. Agathe des Monts and news reports indicated felt effects north of St. Jerome, we decided to commence questioning at St. Jerome. Figure 1 shows the area of reported observations with estimated Mercalli Intensity.

Estimated Mercalli Intensity

- | | |
|---|--------|
| St. Jerome (Pierre Boyer Shell Station) | II |
| - vibrations felt by the night operator - lasted 5 seconds | |
| - lightly rattled the large garage doors | |
| - unconstrained tires on a rack on the rear wall moved slightly | |
| - no noted damage. | |
| Lesage - Service Station just south of Lesage | II |
| - awoke few people of the area | |
| - lightly felt by several but not most | |
| - no noted damage, nothing fell from shelves or tipped over. | |
| Mont Rolland | III-IV |
| - one person, seated on a concrete balcony, felt vibrations after hearing a loud noise | |
| - vibrations estimated to last 30 seconds | |
| - his brothers were awakened | |
| - Officer at St. Adele Police Station (living in Mont Rolland) described loud bang and flash of light across his ceiling. | |

St. Adele Police Station

IV

- wakened people in general
- officer on duty felt strong vibrations as building shook
- near Lac Masson a Constable Moore reported his lamp tipped over
- person who worked at the Police Station (lived on mountain immediately west of Ste. Adèle) did not feel anything, nor did his dogs indicate anything unusual.

Observation: Police Station sits on hillside - probably on gravel bench - and Lac Masson shoreline areas are probably more "unstable". Buildings immediately around the lake would be on pleistocene sand-gravel sediments. These appear to have been susceptible to vibration while people in buildings situated on or close to bedrock in the same area felt little or nothing.

Val David

IV

- Man was awakened by a loud bang, felt vibrations as his house was shaken and described a flash of light. There was a thunderstorm in the area immediately before the quake, however he felt certain the storm and the earthquake effects were separate.

St. Marguerite Barber Shop

III

- people of the area felt the quake generally
- no reported damage

Ste. Agathe des Monts - Police Receptionist, Taxi stand

IV

- Police station received about 25 complaints
- people reported loud noise and buildings shaken
- no visible damage

St. Faustin

III

- man reported hearing 2 successive large bangs (like thunder claps) followed by decaying reverberating sounds.

- the Motel owner reported that in the portion of the motel built on the sand-gravel deposit - effectively the lakeshore area - the vibrations were felt much stronger than in the portion of the motel seated on a concrete wall (basement) foundation.

Military base guardhouse at Lac St. Denis

II⁺

- night commissionaire reported one large bang (like explosion) and light flash different from a lightning flash. There was no storm in the area at the time
- guardhouse (20' x 20' single story frame structure) shook
- duration of vibrations felt was about 3-4 seconds
- large watermain (10 inches) was broken just beside guardhouse. this watermain reportedly is set in a concrete collar in the wall of a manhole. It has broken frequently in the past because no flexible collar was put around the pipe before setting it in concrete. Thus any relative adjustment between the pipe and manhole cracks the pipe. On the morning of the earthquake it was noticed in the Base pumphouse that their pumps were working steadily yet their reservoir was still emptying. This indicated that the system had commenced leaking sometime between midnight and 06:00 hours. The break and the quake could, therefore, be coincidence. No other damage was reported on the Base.

Morin Heights

III

- a soldier at Lac St. Denis lived in a mobile home in Morin Heights. He reported that the trailer shook and cups vibrated in the cupboards. He also reported a loud sharp bang with decaying reverberations
- people at the Town Hall in Morin Heights reported feeling vibrations and being awakened. In the area of Morin Heights houses were shaken and people awakened in general.

Montfort Intersection west of Morin Heights (Service Station attendant)

III

- See 'B' on map
- family reported dishes rattling, and feeling vibrations for about one minute
- reported boulder that had fallen out of a road cut that night
- boulder verified to be large (3'x3'x3') angular boulder that had very recently dislodged from the road cut and slid down about 5' into the ditch, knocking over a small (8', 1 " diameter at base) poplar tree. The road cut here is fractured anorthosite with roots and some soil in the fractures. The boulder in question was obviously in a very sensitive position, however upon inspection its seat was intact and not washed out by rain or other mechanical effects. In retrospect, it had fallen out of the hillside in the same direction (south) as the woodpiles at Lakeview, i.e. to the south. The very distinct possibility remains however, that a passing truck may have caused the dislodgement at this time. The position of the boulder is indicated as 'B' on the map.

Between Montfort Intersection and Lac des Seize Isles

III

- See 'T' on map
- 18' trailer mounted on 3'x6"x6" unbolted wooden blocks on pleistocene gravel deposit shook strongly but nothing fell off shelves or was damaged inside.

Lac des Seize Isles

III

- no disruption noted in cemetery
- noise reported similar to large thunderclap (no storm at the time)
- General Store keeper noted nothing had fallen from shelves

- she reported that customers that day had mentioned feeling strong vibrations and hearing the noise in cottages along the lake
- one of her customers mentioned that small rocks and sand had fallen from "cliffs" behind the cottage some three hours before the earthquake
- in general people around the lake were awakened by the loud bang and vibrations

Weir: General Store

III

- owner was awakened by strong vibrations
- rattled large building facade made up of 6'x6' panes of glass
- nothing fell off shelves, nor was there any other damage reported
- bedrock outcrops immediately to the rear of the building

Lakeview: General Store, Proprietor Tom Jones, Lakeview

III

R.R. 2, RUNDLE, Quebec.

- loud bang like thunderclap was heard
- beds shook and general strong vibrations were felt
- people awakened in general
- in general store cigarettes fell off shelf
- part of general store is on jacks, footings of store are on sand
- woodpiles in stream along side of stream valley fell over to the south

Lost River: General Store

II

- windows rattled
- loud noise was heard and vibrations were felt around lake
- general store proprietor felt nothing -- store is concrete block foundation on bedrock

Pine Hill: General Store

- nothing at all

Pine Hill Restaurant

- nothing at all

South of Dalesville: General Store

- nothing at all

Brownsburg

I

- heard and weakly felt in house "on rock" with poured concrete foundation
- woke man up
- duration of vibrations felt was about three seconds

In general it appears effects were greatest in river and lake valleys where buildings, woodpiles etc. are seated on relatively unconsolidated sand-gravel sediments. Effects of the earthquake were minimal on bedrock. The impression of the explosion-like sound was strong in most observers' minds. Descriptions indicated the sound immediately preceded the felt vibrations.

Following the road trip, it was felt a few more testimonials would prove beneficial to obtain a more detailed isoseismal map. Based on this, S. Mercure telephoned priests whose parishes were located within a 35 km radius centred on the estimated epicentre to glean as much information as possible. Thence, it was decided for the sake of clarity to list village and city names according to a geographical pattern. Starting with the most southeastern municipality, the enumeration will wind up with the farthest northwest centre. For each village or town, the estimated mercalli intensity is written

opposite to the geographical name on the right-hand side. These numbers were used in conjunction with those from the field trip to establish the Ste. Agathe earthquake isoseismal map.

St. Antoine	(0)
- not felt	
St. Canut	(0)
- not felt	
St. Colomban	(0)
- not felt	
St. Jerome	(II)
- rumbling sound heard by nuns working night shift in nearby hospital	
- no report of vibration as such	
Bellefeuille	(0)
- not felt	
Lesage	(II)
- very few people woke up	
- reports of approaching rumble	
St. Sauveur des Monts	(IV)
- people woke up	
- explosion-like noise lasting at most 1 minute	
- vibration strong enough to shake bed and windows	
- foundation on unconsolidated ground (sand and gravel)	
St. Hippolyte	(0)
- to the priest's knowledge none felt the earthquake	

St. Calixte

(II)

- very few felt the quake, the priest woke up, however
- a rumble increasing in intensity and then fading away
- no vibration felt, nonetheless a slight creak was heard
- the Priest's house is located on a rocky elevation with poured concrete basement walls and outside brick walls.

Mont-Rolland

(III)

- several people woke up
- rumble heard and afterwards vibration felt
- according to two young girls' testimony pieces of furniture on casters rolled about in their room

Ste. Adèle

(IV)

- awoke several people
- a loud passing rumble
- vibration felt not strong enough to cause any objects to oscillate

Val-David

(IV)

- several people woke up
- the priest's housekeeper woke up at roughly 3:40 a.m. Heard a sudden muffled sound and then a dying-off rumble
- she felt her bed being shaken and heard some bottles rattling in the medicine chest
- house located in a little depression

Ste. Agathe des Monts

(IV)

- several people were awakened by a thunder or explosion-like noise
- one priest reported having felt no vibration and following the initial sound he heard a ten-second rumble
- another priest talked about a short-duration vibration which caused small objects to sway in a house located on a rocky elevation

Ste Lucie (III)

- several people woke up because of a thunder-like sound
- weak vibration was felt

Notre-Dame de la Merci (III)

- priest was awakened by a vibration relatively strong, then he heard a detonation-like noise
- the house is on cement-poured foundation on top of unconsolidated ground

Val-des-Lacs (IV)

- several people woke up
- a very loud thunder-like sound was heard
- a strong vibration caused the windows to rattle in their frames. However, floors did not seem to have been set into motion
- the house is built with part of the foundation resting on rock

St. Donat (IV)

- at least 5 or 6 homeowners were awakened by a noise
- windows rattled under the effect of the quake
- in this last case the house was on loose ground with cement-poured foundation close to Lake Archambault
- it was found that people felt more intensely the vibration the nearer they were to the mountain

Lachute (0)

- not felt

Morin Heights (IV)

- several people woke up
- very few details available

Ste. Adolphe d'Howard (III)

- according to the priest, there was no noise and only a very weak vibration

St. Faustin

(III)

- several people were awakened by a muffled sound lasting 2 to 3 seconds
- vibration felt to the extent where windows rattled
- the house is seated on loose ground with cement-poured foundation
- strange animal behaviours were observed (by the priest)

1. A cat scratched its master a few seconds before the earthquake

2. A dog climbed in its master's bed just before the tremor

In each case, the behaviour was said to be extremely unusual.

3. It was found the day of the earthquake that horses had jumped over the fence of their corral.

Huberdeau

(III)

- testimony from an already awakened priest at the moment of the earthquake
- he heard a low rumble and felt a weak vibration equivalent to what a big truck would cause
- he thought it was not strong enough to wake people up
- he sleeps on the second floor of a house built on gravel and sand.

St. Jovite

- a very deep rumble lasting approximately 20 seconds was heard
- very few people were awakened

By comparing the earthquake effects reported by the telephone survey with those observed by the field party in the various centres, it can be said the telephone survey leads to maps of reduced intensity. Observations from St. Adolphe d'Howard exemplify this fact. While our interlocutor mentioned only a weak tremor, we observed hairline cracks in basement walls and heard testimony of strong vibrations.

It should be noted that telephone isoseismal surveys have generally been done by calling the parish priests of the region. The churches and residences of the priests, being historically among the oldest in the communities, were usually built on prominent sites. The prominence of the site was often due to the presence or proximity of bedrock. Thus observations reported from such sites might be expected to be of lower intensity than the more dramatic effects we observed since the latter were invariably effects found on a sand or gravel deposit. The inability to assess the stability or geological characteristics of sites where the earthquake effects are reported is an obvious weakness in telephone surveys. Several calls to the same area, instead of only a single call in this case, might help make the judgement of intensity more accurate.

As an extension to the field survey, Dr. Whitham asked that we compare the intensity obtained from field observations with Milne's empirical formula based on the magnitude M . (Milne, W.G. and A.G. Davenport, 1969). The overlay on Figure 1 shows that predicted intensity vs. distance distribution according to Milne's Formula. It appears that the empirical formula tends to overestimate the extent of the low intensity zones (III) and underestimates the extent of the higher intensity zone (IV).

In addition to being an isoseismal survey, this exercise attempted to record aftershocks. To this end two smokers (one vertical, one horizontal, N-S) were installed west of St. Adolphe d'Howard at 17:30 EST, 77/7/14. This location is 6 km south of the preliminary epicentre.

The following is a summary of operation time for these two recorders.

H time July 14 07:39:30 GMT Mag 3.5

1st Instrument (SPH)

on:	July 14	22:52 GMT	0-30 Hz	90dB
off:	July 15	12:29 GMT		
on:	July 15	12:44 GMT	0-30 Hz	84dB
off:	July 15	18:48 GMT		

2nd Instrument (SPZ)

on:	July 14	23:15 GMT	0-30 Hz	84dB
off:	July 15	12:49 GMT		
on:	July 15	12:54 GMT	0-30 Hz	84dB
off:	July 15	18:59 GMT		

Since a setting of 84 dB at 0-30 Hz gives a magnification of 400 k at 10 Hz and since a $M = 0.0$ earthquake, at an epicentral distance of 25 km, would generate a 0-to-peak maximum trace amplitude of about 2 mm, it may be concluded that no aftershocks with $ML \geq 0.0$ were recorded during this survey. This result is in accord with previous experience. It is generally felt that little information can be obtained by an aftershock study which commences several hours after the mainshock since the subsequent events are typically more than 3 orders of magnitude smaller and evidently occur within a few hours of the mainshock. The implications are that if aftershock recording cannot be initiated within a few hours of the main event, it is of dubious value to do aftershock recording for events below about $M = 4.5$.

General observations and conclusions

- effects were greater in mobile homes and buildings or features sited on loosely consolidated sediments
- with one exception sound effects are described to precede felt vibrations. This observation is also reported from Japan. The following is an excerpt from a letter from Dr. Kiyoo Mogi in reply to a question from Dr. H.S. Hasegawa. It reads: "In Japan, we have a number of such examples. The most remarkable case is the Matsushiro earthquake swarm which occurred in the central part of Honshu from 1965-1966. In this case, a loud noise just before a tremor was heard frequently by a number of investigators. Dr. H. Sekiya recorded the noise together with seismic waves. He concluded that the noise corresponds to the P-waves and the tremor to the S-waves. If an earthquake is not so large, people cannot feel the P-wave, but feel the S-waves. This is the case which occurred in your country. If an earthquake is larger, people can feel both the P- and the S-waves. I think, this explanation is reasonable."
- Some observed effects are greater than have been confirmed to date for magnitude 3.5 earthquakes in the area but weaker than anticipated based on Milne's empirical formula for intensity vs. distance. Milne's curves derived for larger events at a depth of 18 km suggest a more gradual attenuation of isoseismal effects but a higher epicentral intensity than observed. If the present event is shallower than 18 km the observed steeper isoseismal attenuation is explained, however it does not account for the lower epicentral intensity.
- From the testimony given by the witnesses and our own first hand observations, it is our considered opinion that the disruptive surface effects are probably a result of the July 14th earthquake

Recommendations

In post-event surveys of this type it must be decided which is more important, the aftershock study or the isoseismal information. For earthquakes farther than about 2 hours driving time from Ottawa it is virtually impossible for 1 team to do both adequately.

In this case, it was decided before leaving Ottawa that priority would be given to soliciting isoseismal information. However, since the process of discovering and studying the surface effects required unforeseen amounts of time, the study is hampered by the requirement to regularly refurbish the seismograph station.

While it is absolutely essential to set up seismographs within a few hours to record any aftershocks, it is also necessary to gather isoseismal information as quickly as possible after the event. In our case, after only 24 hours, we found it more difficult to separate the witness' experience from what she or he had heard on the radio or been told by others from in or around the area.

We, therefore, recommend the following:

- (1) In the case of events of M 3.5 where relatively strong felt effects are reported, - where feasible and when possible, the effects should be checked out by EPB teams rather than accepting press reports. We recommend that further studies of small events be carried out to gather more detailed information on the particular nature of the low level seismicity of the southwestern Quebec region.
- (2) Investigation crews should consist of 2 individuals, 1 bilingual member where appropriate, both for reasons of safety and perhaps more importantly to provide a more unbiased assessment of witness' accounts.

(3) The present practise of maintaining smoker seismograph units should be continued.

(4) Adequate emergency funds be available.

In our case we were under the "general impression" that the survey should be about 2 days. If two teams are deployed for a M 3 event this period may be appropriate. However, in our case, a 3 to 4 day study would probably have yielded more worthwhile data.

If aftershocks are to be recorded at all we believe it essential that the pre-deployment discussion-decision phase (in selecting personnel, etc.) be minimized so that once learning of the event, the teams could react on a "go" decision from the Director.

Acknowledgements

We would like to express our appreciation to R.J. Wetmiller, H.S. Hasegawa, A. Stevens and R. Horner for much constructive discussion and criticism in helping us to appreciate the intensity effects.

Bibliography

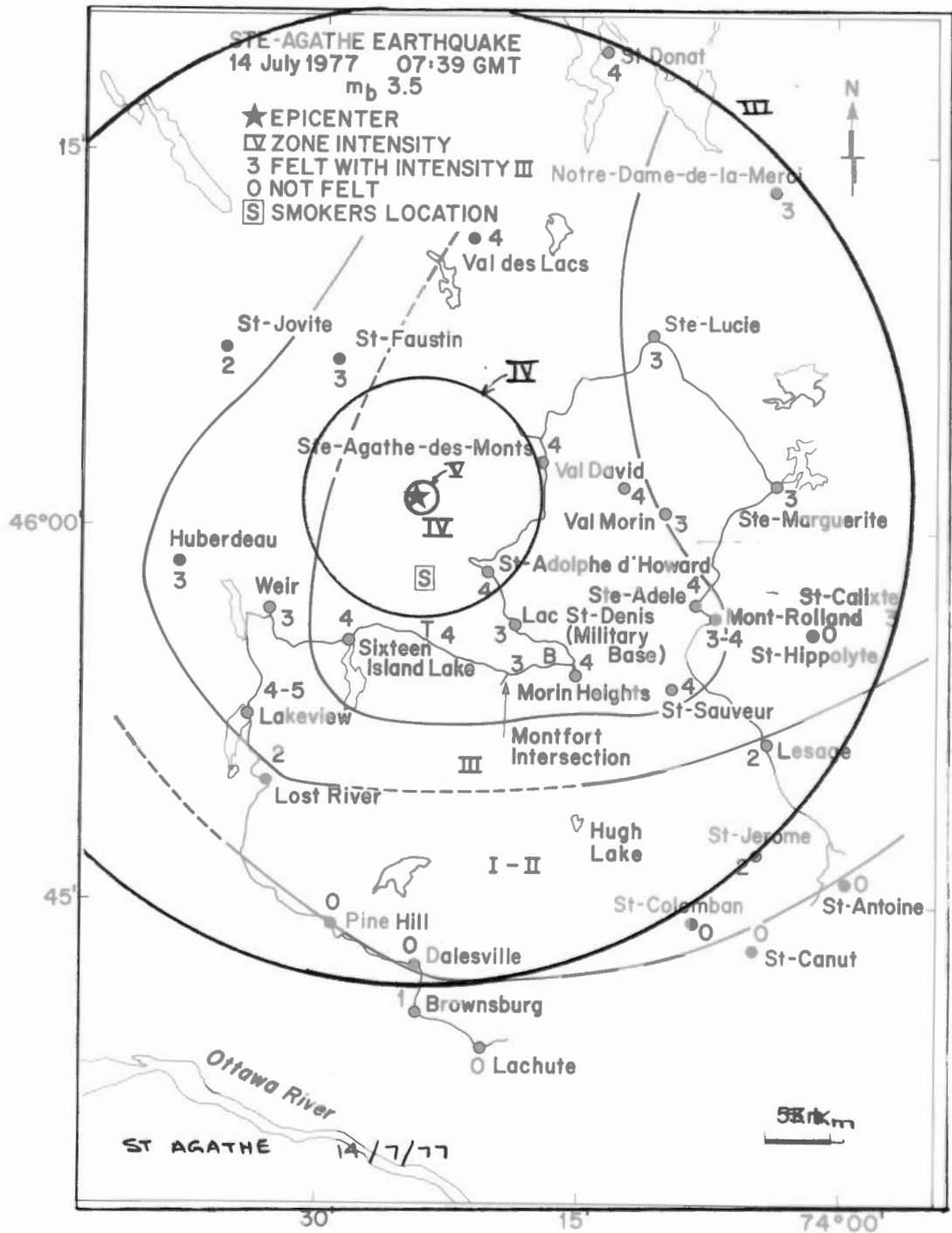
Milne, W.G. and A.G. Davenport, 1969. Distribution of earthquake risk in
Canada. Bull. Seism. soc. Am., 59, 729-754.

Figures

Figure 1 Isoseismal map with predicted intensity overlay

Pictures

- Picture 1 Road cut boulder west of Morin Heights
- Picture 2 Parged concrete-block foundation at lakeshore suburb Ste-Adolphe
d'Howard.
- Picture 3 Close-up of crack in foundation at Ste-Adolphe d'Howard.
- Picture 4 Soil type near cracked foundation
- Picture 5 Painted concrete floor - lakeshore suburb of Ste-Adolphe
d'Howard.
- Picture 6 Woodpile at Lakeview.
- Picture 7 Woodpile at Lakeview.





ROAD CUT BOULDER
WEST OF MORIN HEIGHTS

2005
C. 77087-4
22.7.717



NEW
CRACK
SEE CLOSE
-UP

REACTIVATED
CRACKS

3.5cm
1 1/2"

FOUNDATION

8" CONCRETE BLOCK

LAKE SHORE SUBURB

ST. ADOLPHE D'HOWARD

✓
S.G.

TT1027.5

22-7-77



CLOSE UP CRACK ST ADOLPHE

L-L-88

L-L-87-7

P. 300



SAND
LENSES

OLD
BEACH
DEPOSITS.

SOIL TYPE <100' FROM CRACKED FOUNDATIONS

1-28-77

77087-6

22-7-77



PAINTED CONCRETE FLOOR LAKESHORE SUBURB
ST ADOLPHE

1208
-17027-8
dia. 7-77



Jog. 77087-1

22-7-77

WOODPILE LAKEVIEW



Neg. 17087 2

22.7.77

WOODPILE

LAKE VIEW