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Tsunami Runup Mapping As An Emergency Preparedness Planning Tool:

The 1929 Tsunami In St. Lawrence, Newfoundland

Volume 1

Acknowledgments

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TSUNAMI RUNUP MAPPING AS AN EMERGENCY PREPAREDNESS PLANNING TOOL: THE 1929 TSUNAMI IN ST. LAWRENCE, NEWFOUNDLAND

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EXECUTIVE SUMMARY

TSUNAMI RUNUP MAPPING AS AN EMERGENCY PREPAREDNESS PLANNING TOOL: THE 1929 TSUNAMI IN ST. LAWRENCE, NEWFOUNDLAND

A tsunami struck the Burin Peninsula of Newfoundland in the early evening of November 18, 1929 after the 1702 NST magnitude 7.2 earthquake occurred in the Laurentian Slope Seismic Zone. This event is Canada's most tragic earthquake with twenty-eight lives lost. The tsunami swept into the coast of Newfoundland two-and-a-half hours after the seismic event near the top of a high spring tide. Water levels first fell far below normal then, in three successive waves, that often arrived on shore as breaking waves, water levels rose two to seven metres. At the heads of several of the long narrow bays on the Burin Peninsula the momentum of the tsunami carried water as high as 27 m. St. Lawrence at the head of Great St. Lawrence Harbour was one of the communities inundated, fortunately with no loss of life, but with substantial property damage.

The collective community memory of St. Lawrence has been sampled through oral history interviews with senior community members aged 72 to 96 years, through first-hand reports of residents published in late-1929 newspaper accounts, and through various other published and unpublished accounts available. These recollections have been transcribed onto a 1:2,500 contoured topographic map of the community to map the 1929 tsunami runup zone. The map indicates a tsunami height of about 4 m, a runup height of about 13 m and a runup distance of at least 760 m at the head of the harbour.

St. Lawrence has grown since 1929 and has encroached steadily into the 1929 tsunami runup zone. The report warns of the risk to the community if a 1929-like tsunami were to recur today. Some 30 residences, all the fishing activity, almost all the St. Lawrence commercial activity, its two gasoline stations, the fire station, the RCMP office, the pharmacy, the high school, the recreation centre and soccer fields, the town hall and garage, a water treatment facility, the senior citizens manor, and three important bridges and their related roads could be severely affected. St. Lawrence presently has no planning policies to address further growth in a potential tsunami runup zone and does not have provision for a tsunami alert in its *Emergency/Disaster Plan*.

The report suggests that emergency measures personnel develop a plan that institutes a tsunami alert the moment a strong felt earthquake is experienced in southern Newfoundland. It is suggested that such people be reacquainted with the plan every two years to allow for new or rotating personnel.

While this is the first use of an oral history to establish a tsunami runup zone in Canada, the technique could well apply for storm surge events, seiches, and river flooding events, as well as for other tsunamis such as the March 1964 Port Alberni, B.C. event or in other communities of the Burin that experienced the 1929 event.

CONTENTS

Executive Summary i

Introduction 1

Earlier Scientific Work on the November 18, 1929 Earthquake and Tsunami 5

Description of the November 18, 1929 Earthquake and Tsunami 10

Tsunami Height or Amplitude versus Runup Height 35

St. Lawrence, Newfoundland in 1929 38

Study Approach and Methodology 39

Available Mapping for St. Lawrence 40

Data Available from Printed or Archival Sources 50

Field Program and Oral History Interviews 64

Construction of the Map of the 1929 Tsunami Runup Zone 67

Vertical Datum Uncertainties 72

Construction of the Map of 1995 Modern-day Buildings Within the 1929 Tsunami Runup Zone 73

Conclusions 80

Recommendations and Discussion 81

Acknowledgements 85

Bibliography 95

FIGURES

Figure 1 General index map to the known modern seismicity of eastern Canada 3

Figure 2 Index map to the field area on the south coast of the Burin Peninsula.....7

Figure 3 W.W. Doxsee's 1948 map of isoseismal contours, or lines of equal seismic intensity, drawn around the epicentre of the November 18, 1929 earthquake 13

Figure 4 Map of the area of the November 18, 1929 earthquake epicentre showing the zone of broken marine telegraph cables.....15

Figure 5 Basham and Adams' (1982) map of the epicentres of various 1929-1980 offshore earthquakes 17

Figure 6 Travel time map for the November 18, 1929 tsunami from observed data 19

Figure 7 Plot of the November 1929 hindcast astronomic tidal predictions for North Sydney, Nova Scotia 23

Figure 8 An enlarged portion of the astronomic tidal prediction curve for November 18 and 19, 1929 for North Sydney,Nova Scotia 25

Figure 9 Tad Murty's 1977 model estimates of the travel-time curves for the November 18, 1929 tsunami 33

Figure 10 An enlarged portion of the current 1:50,000 topographic map for the St. Lawrence area.....37

Figure 11 Portion of the 1978 (modified to May 22, 1991) Chart 4642 of the St. Lawrence Harbours 43

Figure 12 Portion of the 1978 (modified to May 22, 1991) Chart 4642 inset map of Great St. Lawrence Harbour (Inner Portion) 45

Figure 13 Index map at 1:50,000 to the series of eight Newfoundland and Labrador Department of Environment and Lands (1988) 1:2,500 maps of St. Lawrence.....47

Figure 14 Index map at 1:250,000 of the two May 27, 1987 flight lines over St. Lawrence showing the photo centres of each negative 49

TABLES

Table 1 Travel times and speeds of the November 18, 1929 tsunami as slightly revised from Berninghausen's (1968) Table II 20

Table 2 Community losses of codfish in the 1929 tsunami, for twenty-three Burin Peninsula communities from St. Lawrence east to Rock Harbour 62

Table 3 Log of interview tapes and interviewees 66

Table 4 List of existing businesses, agencies, homes and facilities that may be at risk if a 1929-like tsunami is repeated in St. Lawrence, Newfoundland 88

FOLDOUT MAPS

Map 1 Area Flooded by the 1929 tsunami, St. Lawrence, Newfoundland 74

Map 2 Modern-day Buildings and Uses Susceptible to a 1929-like Tsunami, St. Lawrence, Newfoundland 76

INTRODUCTION

Normally persons concerned with emergency preparedness measures do not usually think of eastern Canada or eastern North America as an area prone to severe earthquakes. It is not. Certainly, no part of eastern North America suffers the earthquake risk of California, or the potential and probable earthquake risk of the southern coastal parts of British Columbia. However, this area of Canada is not immune to large seismic events (Figure 1; Smith, 1962, reprinted 1972).

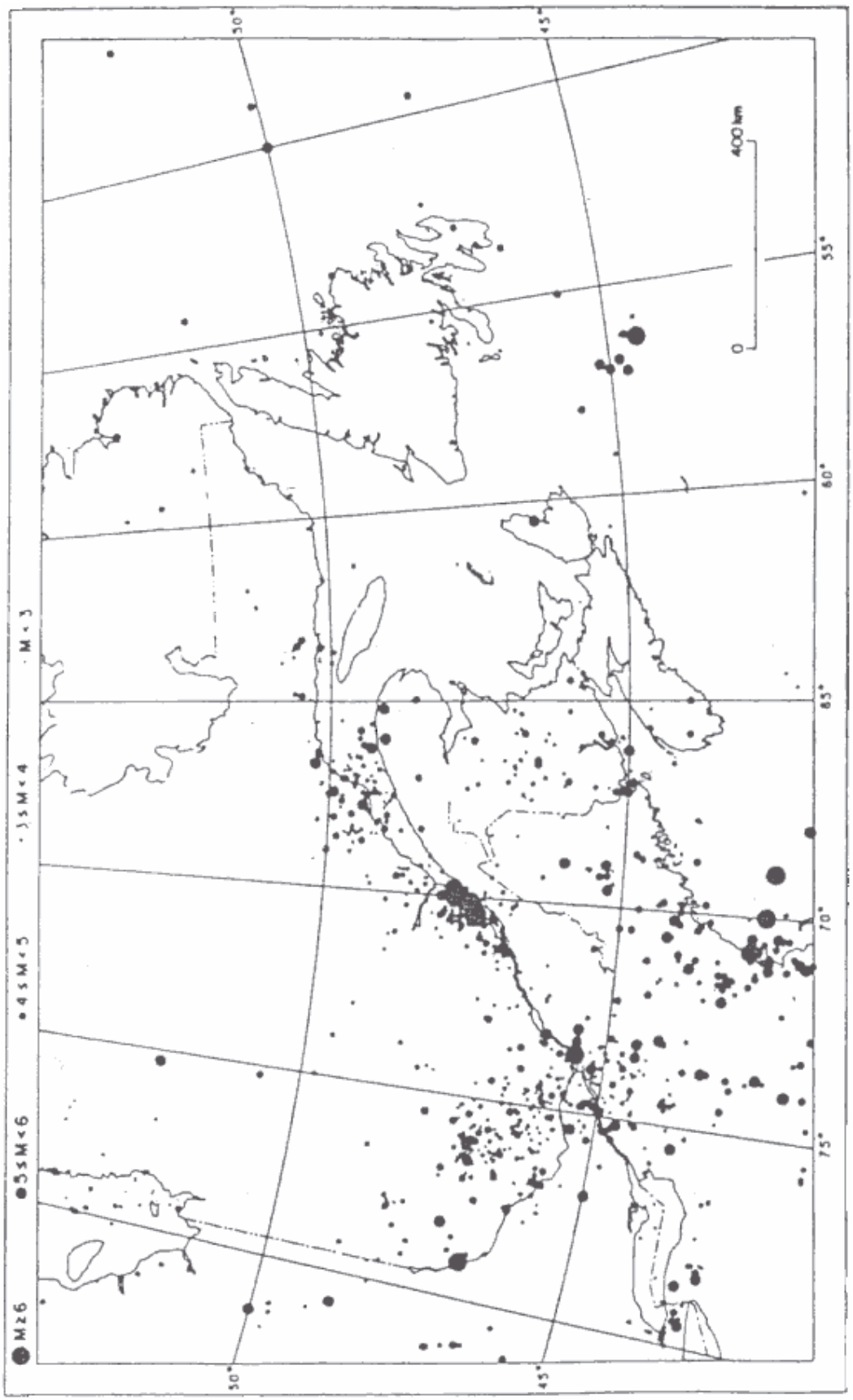
The major 6.5 to 7.0-sized [1] events of 1886 at Charleston, South Carolina, the 1755 marine event off Cape Ann near Boston, the 1929 event on the Laurentian Continental Slope off southern Newfoundland and eastern Cape Breton Island in Nova Scotia, and the 1933 event offshore in Baffin Bay all serve as reminders that we have experienced large earthquakes in eastern North America. In 1929 southern Newfoundland experienced a tsunami that cost 28 lives. Indeed, the November 18, 1929 magnitude 7.2 earthquake which struck at 1702 NST is Canada's most tragic earthquake. The earthquake shook loose a portion of the continental slope over a 20,000 km^2 area and the resulting turbidity current flowed at 70 km/hr to redistribute 200 km^3 of material over a 150,000 km^2 area on the Sohm Abyssal Plain. The sudden slumping of a large volume of the ocean floor set up a long period wave on the ocean's surface; this is referred to as a tsunami — often incorrectly called a 'tidal wave'. Since 1929 a number of other quite large earthquakes in the magnitude 5 to 6+ range have occurred in the same area in what is now called the Laurentian Slope Seismic Source Zone.

The 1929 tsunami has shown that the Laurentian Slope (LSP) Seismic Zone at the mouth of the Laurentian Channel is a potentially tsunamigenic seismic zone (Ruffman, 1991a; Ruffman *et al.*, In Preparation a; b). There may be another significant seismic source zone off southwest Nova Scotia. Historical seismicity work by the author in Nova Scotia for the period 1752 to 1867 doubled the known number of felt events in Nova Scotia (Ruffman and Peterson, 1986). What was interesting about this work is that it indicated that the southeastern tip of Nova Scotia and the southwestern area close to the mouth of the Bay of Fundy seem to have experienced the largest number of felt events. A recent chance find by Ms. Peterson has turned up yet another event in the Yarmouth area. All these findings tend to support a previously-unrecognised offshore Gulf of Maine seismic zone that may even have been tsunamigenic (Ruffman, 1991c).

[1] The earthquake magnitudes used in this report are as defined on the Richter scale.

Figure 1

General index map to the known modern seismicity of eastern Canada showing epicentres grouped for events of magnitudes of 6.0 and greater, 5.0 to 5.9, 4.0 to 4.9, 3.0 to 3.9, and less than 3.0 as taken from a report by Basham, Morel-à-l'Huissier and Anglin (1982). This diagram does not reflect epicentral changes that will eventually be made as a result of the recent historical seismicity work of the Geological Survey of Canada in the work of Burke *et al.* (1985; 1987; 1990), Burke and Comeau (1988), Burke and Gerd'son (1988), Ruffman and Peterson (1986), or Staveley *et al.* (1984; 1986).


30°
45°
55°
60°
65°
70°
75°
400 km
0
M≥6
5≤M<6
4≤M<5
3≤M<4
M<3

Similarly, the southernmost area of New Brunswick in the Passamaquoddy Bay area adjacent to the Maine border harbours a poorly understood seismic zone. In the past, the Passamaquoddy Bay seismic zone has spawned many earthquakes up to magnitude 5.9 in size (Figure 1). This seismic zone will get further recognition in the new 1995 Building Code of Canada with a strengthening of the code for construction susceptible to the now, better-understood, seismic risk. This new understanding has almost exclusively come from the historical seismicity work funded by the Geological Survey of Canada in New Brunswick and Nova Scotia. A very nice piece of historical seismicity sleuthing has been done by Leblanc and Burke on three larger New Brunswick events and on a Maine event (Leblanc and Burke, 1987). In this, a northern Maine event, originally classed as having a magnitude of 5.2, was relocated to Passama-quoddy Bay, and raised to a magnitude 5.9 event; the Lepreau nuclear plant 40 km away is rated for a possible event up to a magnitude of about 6.0 at 20 km from the site (Parnian and Duff, 1975).

The main concern for emergency measures personnel when a tsunami is created by a large offshore earthquake is that at the shoreline the arrival of the tsunami wave can cause a rapid apparent rise of sealevel that can carry some distance inland, well beyond the reach of even the highest storm waves. The tsunami can also cause the ocean level to fall and boats at anchor, or at wharves, may topple over and flood. Thus the 'height' of the tsunami, the 'runup distance' and 'runup height' of the tsunami become key factors in defining the potential seriousness of the event. The tsunami wave 'height', or amplitude, at any point is the excess height of the tsunami wave over the normal ocean level as it passes that point. In a calm sea a vertical piling driven into the ocean floor is wetted to a certain level depending on the state of the astronomic tide. If a tsunami were then to pass, the piling would be wetted to a higher level and the difference of the two wetting levels is the tsunami's height or amplitude. In practise, seldom can the height of each tsunami pulse be recorded unless there is a suitable tide gauge functioning in the area. Usually, the tsunami height reported from such an observer's data (eg. a ship rising and falling at a wharf), or from post-tsunami field data, is the height of the largest pulse.

Similarly, the tsunami runup distance recorded from debris lines or flattened vegetation in the field is that of the most energetic pulse that carries the farthest inland. The 'runup distance' is the distance from the normal tide line, or shoreline, at the time of the tsunami's arrival to its maximum extent inland. The 'runup height' is the elevation of the point of maximum runup above the normal ocean surface at the time of the tsunami.

Tsunamis in the Atlantic Ocean are relatively rare. Tsunamis on the Atlantic coast of the United

States have been recognised on tide gauges with amplitudes of only a few centimetres, eg. Lander and Lockridge (1989) on p. 204 record a May 19, 1964 tsunami of a maximum amplitude of 11 to 28 cm and a period of four minutes. Clearly these very small events would not be recognised by an observer on the seashore and there would be imperceptible runup. Such events pose no danger to humans or to their built structures along the shoreline.

In the case of the 1929 tsunami the tsunami heights in the Province of Newfoundland along the Burin Peninsula were in the order of several metres, runup distances were in the order of a kilometre or more, and runup heights were over ten metres if the geometry of the bay and shorelines were such as to maximize the effects. As we shall see in this report, St. Lawrence on the Burin Peninsula of Newfoundland was one such bay where the 1929 tsunami posed a very real threat as it swept in on the early evening of Monday, November 18, 1929, near the time of the normal astronomic 'spring' tide.

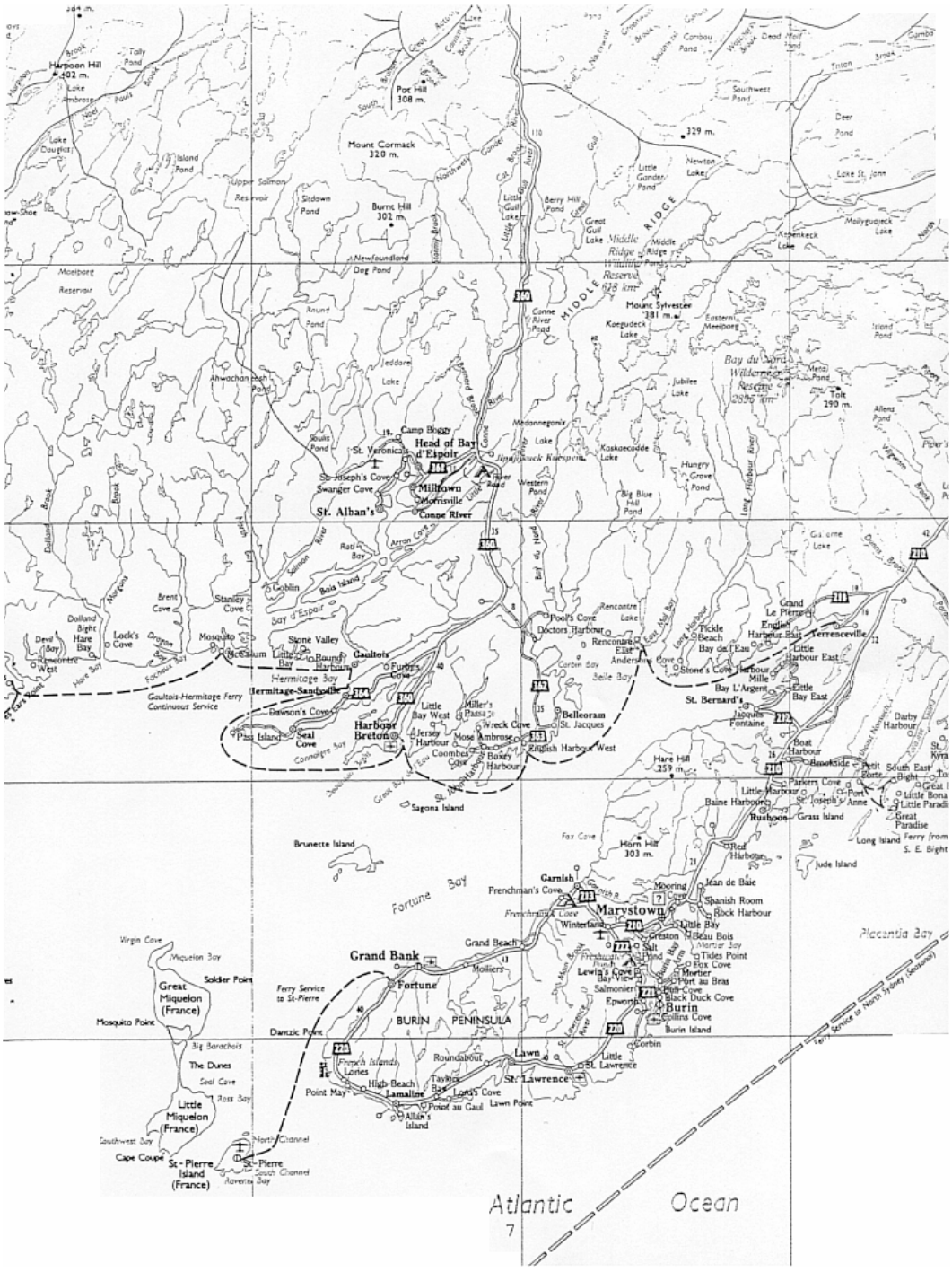
EARLIER SCIENTIFIC WORK ON THE NOVEMBER 18, 1929 EARTHQUAKE AND TSUNAMI

The promotional sheet for the Provincial Archives of Newfoundland and Labrador's exhibit 'Tidal Wave Disaster, November 18, 1929' which opened in St. John's, Newfoundland on November 18, 1992 contained the following abbreviated review:

> **The Burin Peninsula in 1929 was still very much a part of the rural and marine resource based economy typical of nineteenth century Newfoundland. In 1921, Burin District had 12,579 inhabitants dispersed among 78 communities. This District had a very productive inshore fishery as well as a large and viable bank fishery.**
>
> **The earthquake and tidal wave occurred on Monday, November 18, 1929. Tremors were felt throughout Newfoundland at about 5:00 p.m. and around 7:30 p.m. the tidal wave struck the Burin Peninsula. The huge wave destroyed homes, fishing boats, wharves, flakes and stages in many communities and took the lives of 27 people.**

Figure 2

Index map to the field area on the south coast of the Burin Peninsula. The map is taken from the 1993 Province of Newfoundland and Labrador road map put out by the Newfoundland Department of Tourism and Culture. Roundabout is incorrectly shown as being on the road that runs from Lawn to Taylor's Bay when in fact it is on the coast to the southwest of Lawn — further Highway 220 runs from Lawn to Lord's Cove directly and then on to Taylor's Bay rather than as shown on the Province's current road map.


Harpoon Hill
402 m.
Pot Hill
308 m.
Mount Cormack
320 m.
Burns Hill
302 m.
329 m.
MIDDLE RIDGE
Mount Sylvester
381 m.
Bay du Nord Wilderness Reserve
2895 km²
Tolt
290 m.
Head of Bay d'Espoir
Camp Boggy
St. Veronica's
St. Joseph's Cove
Swanger Cove
Millertown
Morrisville
Conne River
St. Alban's
Hermitage-Sandyville
Gaultois-Hermitage Ferry
Continuous Service
Gaultois
Hermitage Bay
Harbour Breton
Dawson's Cove
Seal Cove
Pass Island
Fortune Bay
Sagona Island
Brunette Island
Pool's Cove
Doctors Harbour
Rencontre East
Belleoram
St. Jacques
English Harbour West
Wreck Cove
Miller's Passa
Mose Ambrose
Bunker Harbour
Coombes Cove
Jersey Harbour
Little Bay West
Stone's Cove
Harbour
Mille
Bay L'Argent
St. Bernard's
Jacques Fontaine
Little Bay East
Terrenceville
Little Harbour East
English Harbour East
Tickle Beach
Bay de l'Eau
Grand Le Pierre
Hare Hill
259 m.
Brookside
Parkers Cove
Little Harbour
Baine Harbour
Rushoon
Grass Island
St. Joseph's Anne
Great Paradise
Long Island
Ferry from S. E. Bight
Jude Island
Red Harbour
Horn Hill
303 m.
Fox Cove
Garnish
Frenchman's Cove
Winterland
Marystown
Mooring Cove
Jean de Baie
Spanish Room
Rock Harbour
Little Bay
Creston
Beau Bois
Mortier Bay
Tides Point
Box Cove
Mortier
Port au Bras
Black Duck Cove
Burin
Collins Cove
Burin Island
Corbin
Lewis's Cove
Bay View
Salmonier
Epworth
Grand Bank
Fortune
Grand Beach
Molliers
Ferry Service to St-Pierre
BURIN PENINSULA
Lawn
Little St. Lawrence
St. Lawrence
Roundabout
French Islands
Lones
High Beach
Lamaline
Point May
Taylors Bay
Long's Cove
Point au Gaul
Lawn Point
Allan's Island
Placentia Bay
Ferry Service to North Sydney (Seasonal)
Virgin Cove
Miquelon Bay
Great Miquelon (France)
Soldier Point
Mosquito Point
Big Barachois
The Dunes
Seal Cove
Ross Bay
Little Miquelon (France)
Southwest Bay
Cape Coupe
St-Pierre Island (France)
St-Pierre
North Channel
South Channel
Roberts Bay
Atlantic Ocean

Since the tidal wave knocked out the telegraph system it was not until Thursday morning that St. John's became aware of the disaster. Government quickly loaded supplies and dispatched a medical team on the S.S. MEIGLE to the stricken area.

Newfoundlanders were shocked by the disaster. Appeals for aid quickly resulted in over $250,000.00 being contributed. An independent South Coast Disaster Committee was established to assume full responsibility for the relief effort. This committee distributed food and clothing to the victims and arranged the purchase and delivery of material to rebuild the waterfront properties and to replace boats and fishing gear. Documents indicate that replacing the fishery infrastructure and homes was a priority with the Committee. As a result residents were seldom compensated fully for their other losses.

The Tidal Wave had a devastating ecological impact on the area. During the 1930's, squid, a common bait for codfish, were very scarce. This, together with declining prices for dried codfish during the Great Depression, postponed the economic recovery of this region until the prosperity associated with the Second World War.

While the above review may contain a doubtful conclusion regarding the ecological impact of the 'tidal wave', the November 18, 1929 earthquake and tsunami still stand as Canada's most serious earthquake disaster, both from the point of view of the loss of life and from the point of view of the loss of property. Twenty-eight persons lost their lives in the tsunami along the south coast of the Burin Peninsula of Newfoundland (Figure 2). Yet despite this, the events have received relatively little scientific attention until recent years. This fact stems from several reasons.

Newfoundland was not part of Canada in 1929; it was a colony of Britain, poor and relatively undeveloped. Population was low and scattered in isolated rural fishing outports. There were no roads across the Island until the 1960's and there was not yet a road connection from St. John's to the Burin Peninsula. Newfoundland did not yet have a university of note; there was no industrial base and its scientific establishment was virtually non-existent. There was no seismograph on the Island; there was not even a tide gauge in 1929. Scientific knowledge about Newfoundland came from British, American or Canadian scientists who occasionally visited (Steele, 1987). There was not yet a strong locally-based written or publishing tradition in Newfoundland; indeed, much of the rural population was still relatively illiterate.

While there was a brief spate of scientific articles at the time of the event,[2] there was virtually

nothing written on the events for the next 20 years except the Dominion Observatory's much-delayed and nearly-forgotten report (Doxsee, 1948). Hodgson and Doxsee had done a report on the event in 1930 (a;b) but had not ever produced the final work. Hodgson had retired by 1948, Newfoundland was about to enter the Canadian Confederation, and it was appropriate that Doxsee got the volume done before he too retired. Doxsee's detailed 1948 publication may have then prompted the reexamination of the submarine aspects of the event by the geologists of Columbia University that led to their pivotal papers defining turbidity currents (Ericson *et al.*, 1952; Heezen and Ewing, 1952; Kuenen, 1952; Heezen *et al.*, 1954; Kullenberg, 1954; Shepard, 1954; Heezen and Drake, 1964; Sen Gupta, 1964; Fruth, 1965). In general though, since confederation with Canada, the 'tidal wave' and the 'Grand Banks' Earthquake have spawned a series of sometime superficial and poorly-researched, or secondary, popular pieces that have helped move the 1929 event into the realm of folklore and exaggerated myth.[3]

The 1929 seismic event was re-located and reassessed by U.S. authors (Dewey, 1977; Dewey and Gordon, 1984). In recent years, Canadian scientists have taken a greater interest in the 1929 event through the Atlantic Geoscience Centre and the Earth Physics Branch (now the Geophysics Division) of the Geological Survey of Canada. Recently, in a major re-examination of the event, Allison Bent of the Geophysics Division of the Geological Survey of Canada has used waveform modelling with forward and inverse methods to dismiss the suggestion of Hasegawa and Kanamori (1987) and Hasegawa and Herrmann (1989) that the earthquake resulted from the slump (Bent, 1994; 1995). She has shown that the 1929 event was a tectonic earthquake. She has constrained the focal depth of the first subevent to 20 ±2 km and has shown the first and largest subevent occurred on a northwest-striking plane in a right lateral sense.

Bent calculates M_S to be 7.2 ±0.3 and m_B to be 7.1 ±0.2 with a seismic moment of 7.3 x 10^{19} N m (or 10^{26} dyne cm) which corresponds to her preferred moment magnitude M_w of 7.1 ±0.1. She has concluded from her modelling of the displacement of the ocean floor that the tsunami was set up by the submarine slump, not by any tectonic displacement of the seafloor from the earthquake directly (Bent, 1995). She noted that her values of the magnitude are in reasonable agreement with those of Gutenburg and Richter (1956), Abe (1981) as well as Hasegawa and Kanamori (1987), all of which had M_S and m_B as 7.2, with that of Street and Turcotte (1977; M_S 7.1), and with that of Pacheco and Sykes (1992; M_S 7.0).

Despite the reworking of earlier data to work out a solution for the 1929 and one other earthquake in the LSP, the nature of the tectonic cause of the earthquakes is not yet well

understood. While it is tempting to relate the earthquakes to some residual stresses related to the transform offset along the southern edge of the Grand Banks (Figure 5), or to the major lineament traced out by the axis of the Laurentian Channel, in fact the cause of the 1929 earthquake is not known.

Work in the northwestern U.S., western Canada, Scotland and Japan has shown that one can identify the onshore deposits of tsunamis.[4] In August 1993 a reconnaissance field program on the south coast of the Burin Peninsula (Figure 2) was aimed at establishing whether the 1929 tsunami left an onshore geologic record and whether the onshore conditions are such that evidence of possible earlier tsunamis emanating from the 1929 Laurentian Slope epicentre zone might also have been preserved. Earlier background research by the author had indicated that the maximum runup elevation of the November 18, 1929 tsunami in Newfoundland was probably in Taylor's Bay (Figure 2) on the Burin Peninsula (Ruffman, 1987; Ruffman *et al.*, 1989; Ruffman, 1990a; b; 1991b; c; d; 1992a; b; Ruffman *et al.* (in preparation a; b). The 1993 field work took place under the auspices of the newly renamed Lamont-Doherty Earth Observatory (L-DEO) with Martitia Tuttle in charge as the Principal Investigator. The author was the geologist in the field in 1993 for the initial reconnaissance program when the onshore geological signature of the event was found (Ruffman and Tuttle, 1994a; b; Ruffman, 1994a; b). The author returned to the Burin with his co-investigator in August 1994 and more locations of onshore geological evidence of the 1929 tsunami were found (Ruffman *et al.*, 1995; Tuttle *et al.*, 1995; Ruffman and Tuttle, 1995; Anderson *et al.*, 1995a; b; 1996).

DESCRIPTION OF THE NOVEMBER 18, 1929 EARTHQUAKE AND TSUNAMI

> **The circumstances attending this disaster were most appalling. Suddenly, without warning, the ocean rose up and deluged the land, crushing the people's homes and their possessions in one common ruin for a distance of fifty miles along the coast. Forty towns and fishing villages, affecting a population of 10,000 people, were involved in grief and disaster. It was a time for action, a time for Newfoundlanders to show solidarity and sympathy, a time for service and sacrifice.**
>
> **South Coast Disaster Committee, 1931, p. 5.**

While the above 1931 document is quite valuable with respect to the relief effort it, surprisingly, does not even record the time or date of the earthquake, or of the tsunami that followed. The report does not list the dead. There were no scientific reports on the event that came out of Newfoundland at the time but there was a wealth of primary newspaper reports (Ruffman *et al.*, in preparation a; b; Provincial Reference and Resource Library, 1988).

Papers written soon after the event by Prof. J.H.L. Johnstone (1930) of Dalhousie University's

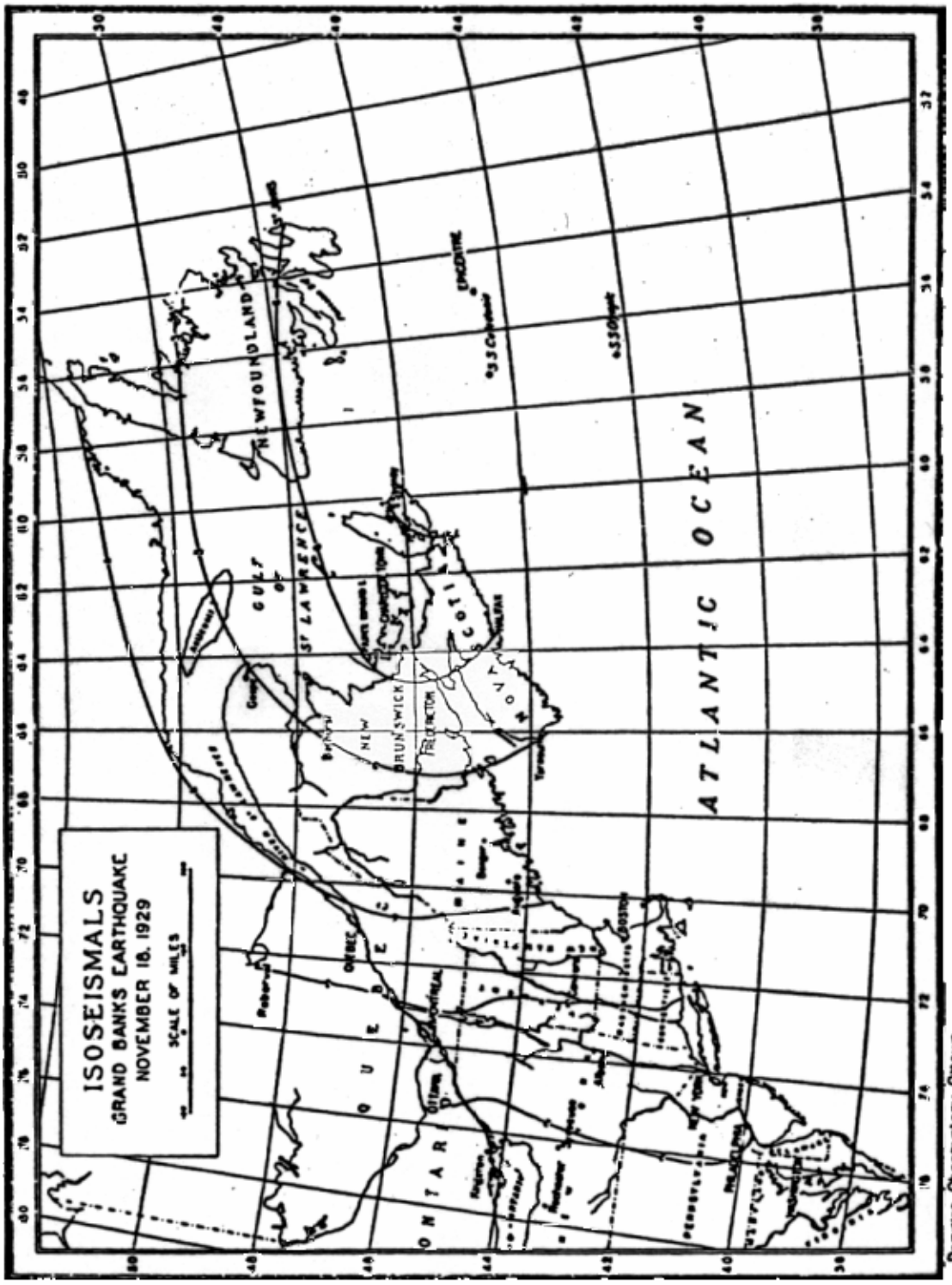
Physics Department and by Prof. D.S. McIntosh (1930) of the Geology Department gave most valuable local observations. Ernest A. Hodgson and W.W. Doxsee (1930a; b) provided information from the Ottawa-based Dominion Observatory and the later W.W. Doxsee (1948) publication from the Dominion Observatory has become a standard reference. Indeed, Doxsee's 1948 map of isoseismals is still the only map available (Figure 3) though additional intensity data in Atlantic Canada are now available to eventually reassess that map (Burke and Slauenwhite, 1987; Gouin, 1986; Ruffman *et al.*, in preparation a; b).

The November 18, 1929 seismic event was felt throughout the Atlantic Provinces of Canada and as far west as Ottawa, Ontario and as far south as Claymont in Delaware (Doxsee, 1948). The significance of the 12 submarine cable breaks in the vicinity of the epicentre (Figure 4) was not realized for 23 years. Doxsee, for example, in 1948 was still interpreting the offshore disruptions and the down-slope progression of the cable breaks in time as evidence of subsidence in the sea floor related to an assumed (down-dropped) graben forming the Laurentian Channel. Such a graben is no longer hypothesized and the recent work of Allison Bent at the Geological Survey of Canada (1994; 1995) has gone a long way to understanding the November 18, 1929 rupture and the aftershocks which followed it.

Basham and Adams (1982) and Adams (1985) have carried out some relocation of the earthquake epicentres in the area of the 1929 event. There are now some data suggesting a zone of activity that may ultimately allow the 1929 fault planes to be defined (Figure 5). These fault planes may relate to faults that can be mapped in the gravity and magnetic potential field data held at the Atlantic Geoscience Centre; work is being carried out in this regard by Dr. Bosko Loncarevic. Bent (1995) briefly reassesses possible relationship of the 1929 event to known tectonic elements in the area.

Figure 3

W.W. Doxsee's 1948 map of isoseismal contours, or lines of equal seismic intensity, drawn around the epicentre of the November 18, 1929 earthquake as interpreted from some 331 observations collected from newspaper reports and from a mailed questionnaire sent out by the Dominion Observatory in Ottawa.



The Grand Banks Earthquake of November 18
(W. W. Doxsee, 1948 - portion only)
Publications of the Dominion Observatory
Vol. 7, No. 7
p.324

Figure 4

Map of the area of the November 18, 1929 earthquake epicentre showing the zone of broken marine telegraph cables. The epicentre was located at the star on the Laurentian Slope at the mouth of the Laurentian Channel. Doxsee's 1948 estimate of the area of the various instantaneous slumps is shown as the shaded area with the solid arc along the front slope of the area being the outcrop of the sole of the presumed slump zone. The broken transatlantic telegraph cables are shown as solid lines and the breaks in these (and others farther downslope — twelve in total) cables are shown as small crosses. The circles represent various cores taken to study the turbidity current disruption. The arrows show the direction of turbidity currents that were triggered by the earthquake. This figure is taken from Heezen and Drake (1964) and is shown as it was reproduced in Hasegawa and Kanamori (1987).

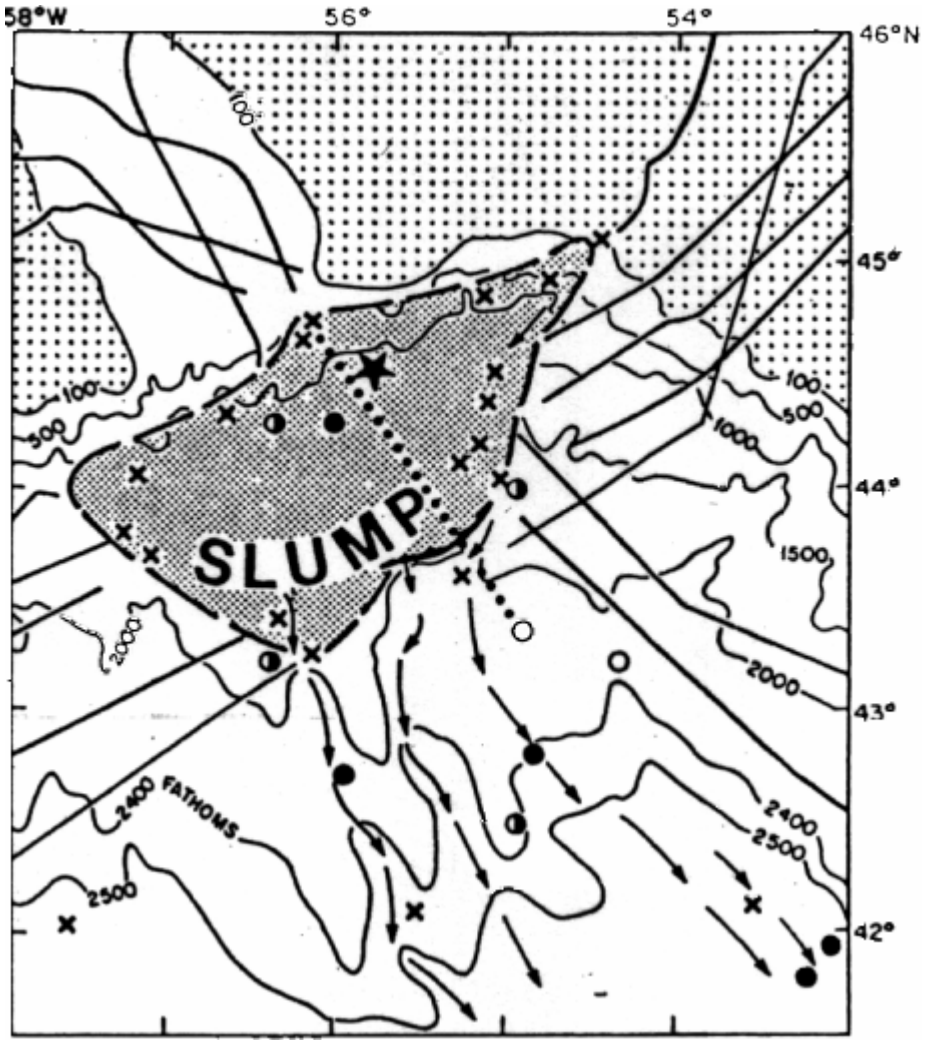

58°W
56°
54°
46°N
45°
44°
43°
42°
100
100
500
1000
1500
2000
2000
2400
2500
2400 FATHOMS
2500
300
SLUMP

Figure 5

Basham and Adams' (1982) map of the epicentres of various 1929-1980 offshore earthquakes. The 200 and 2000 metre isobaths are shown to outline the edge of the continental shelf. The solid triangles show the existing seismograph stations in 1982 and the dashed lines show offshore faults (short dashes = faults observed in shallow seismic data, long dashes = uncertain and inferred faults from magnetic and gravity potential field data). The stippled quadrilateral at the mouth of the Laurentian Channel is the Laurentian Slope seismic source zone (LSP) used in regional probabilistic ground motion mapping by the Geological Survey of Canada (Basham, Weichert *et al.*, 1982; Basham *et al.*, 1983).

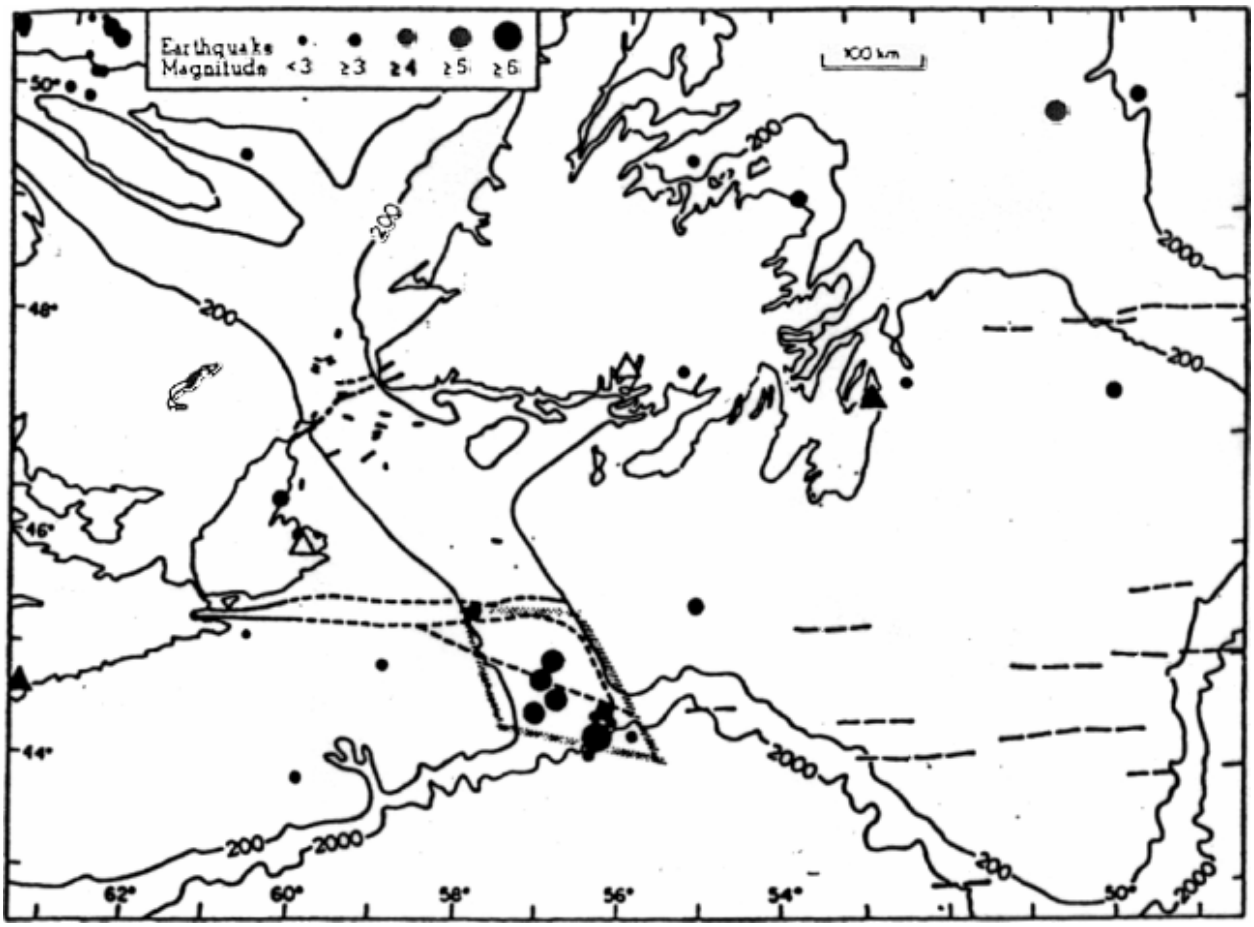

Earthquake Magnitude
<3
≥3
≥4
≥5
≥6
100 km
50°
48°
46°
44°
62°
60°
58°
56°
54°
52°
200
2000

Figure 6

Travel time map for the November 18, 1929 tsunami from observed data. The tsunami was generated at the epicentre located at about 2,000 m water depth on the Laurentian Continental Slope. This map was produced by Berninghausen (1968, p. 42) from directly observed data and from tide gauge data. Tad Murty (1977, p. 267) produced a similar set of curves from model work for the areas close to Nova Scotia and Newfoundland on the continental shelf as seen in a later figure (Figure 9).

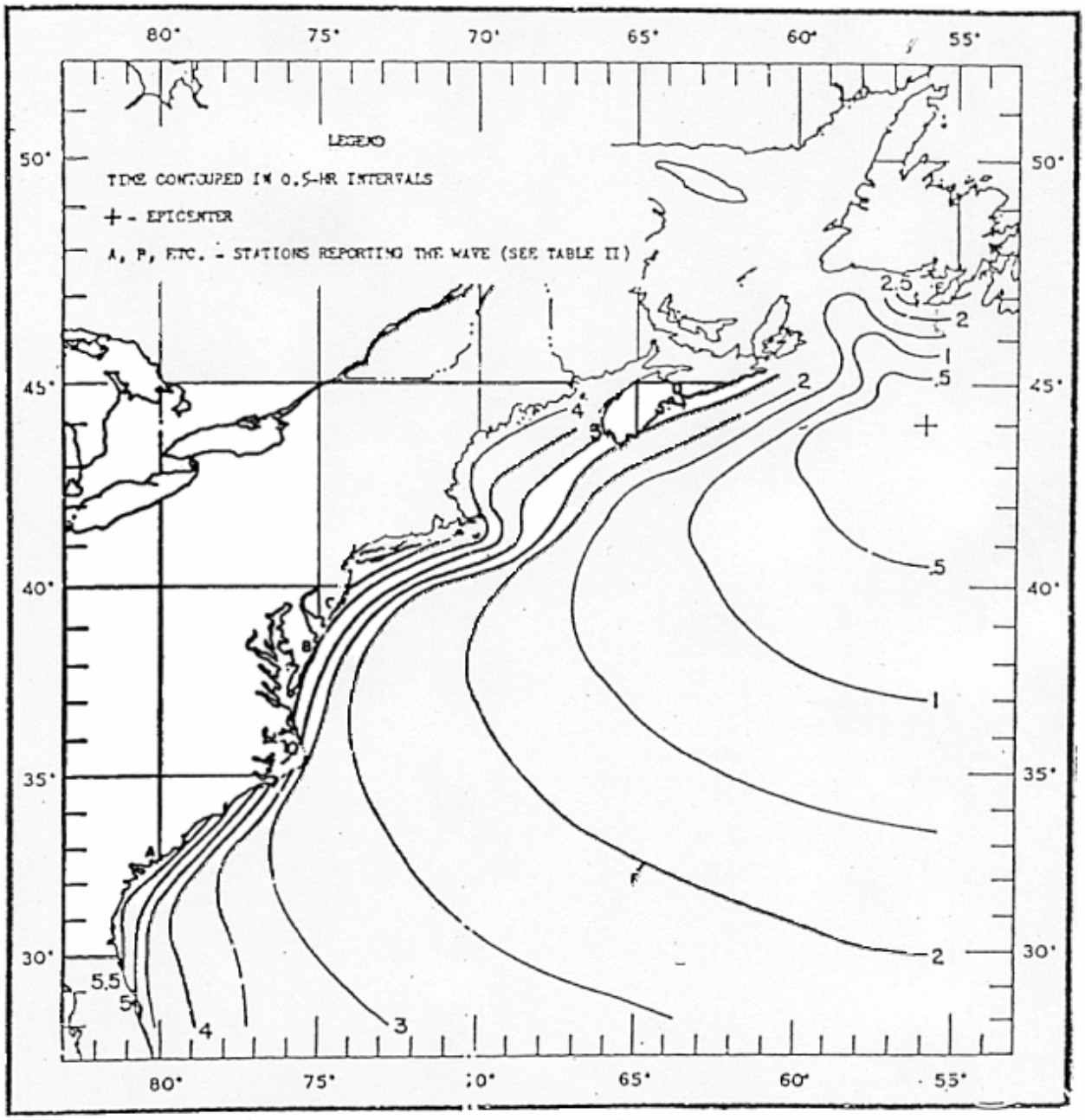


FIGURE 1 TRAVEL TIME CHART FOR TSUNAMI OF 18 NOVEMBER 1929

19

The Monday, November 18, 1929 'Grand Banks' Earthquake occurred at 1632:00.2 EST (2032:00.2 UT); the recently recomputed hypocentre of Dewey and Gordon (1984) is beneath the Laurentian Slope at 44.691°N, 56.006°W with a focal depth of 18.6 km but with a very large uncertainty of ±17 km. This time and position are close to the time of 2032:00.7 UT and position of 44.5°N, 56.3°W respectively which are the currently listed values in the Canadian Earthquake Epicentre File (CEEF). Bent (1995) has given a tightly constrained depth of 20 ±2 km; she does not revise the time or the epicentre position.

The tsunami created by the November 18, 1929 slump on the Laurentian Continental Slope took about 2 hours to reach Bermuda at an average speed of just over 700 km/hr (Figure 6). It took about 2.5 hours to reach the Burin Peninsula of Newfoundland and about 3 hours to reach Cape Breton Island (Figure 6) at an average speed of about 144 km/hr (Table 1).

TABLE 1

Travel times and speeds of the November 18, 1929 tsunami as slightly revised from Berninghausen's (1968) Table II.

Location	Travel Time Observed	Approx.Distance (n mi)	Speed (n mi/hr)	Speed (km/hr)
Burin, Nfld.	2h 23m	185	78	144
Halifax, N.S.	2h 58m	330	111	205
Bermuda	2h 58m	780	265	488
Atlantic City, N.J.	4h 18m	880	204	376
Ocean City,Md.	3h 48m	915	241	444
Charleston, N.C.	5h 52m	1320	226	416

The slower speed indicates the effect of the shallower water on the continental shelf to the north and west of the epicentre. A tsunami has a very long wavelength and it interacts with the bottom of the ocean as it comes onto a continental shelf just as does a broad ocean swell as it approaches a shoaling shoreline. A tsunami has a very long wavelength and hence a very low frequency or period. In the case of the 1929 tsunami approaching Newfoundland, the period of each pulse was about 10 minutes and the wavelength was about 20 km.

A tsunami begins to slow down as it interacts with the ocean floor. It begins to lose energy through frictional losses with the ocean floor and in its final stages as it approaches a shoreline it builds in amplitude again much like an ocean swell approaching a beach. Eventually, like ordinary wind-driven waves arriving onshore, it begins to tear up the sediments on the ocean floor and rises in amplitude so high that the wave breaks to lose energy.

When a tsunami arrives at a shoreline it often is first seen as a withdrawal of the sea; a rapid drop in sealevel. The positive pulse may first arrive as a breaking wave then surge inland as a steadily rising sealevel; a positive rapid rise of sealevel. In the case of the 1929 tsunami as it arrived on the Burin Peninsula, in all cases witnesses report it was first seen at about 1930 NST as a major withdrawal (NST is 0.5 hr ahead of AST used in the rest of Atlantic Canada). In the communities of Lamaline, Taylor's Bay, Lord's Cove and Port au Bras there are reports of a breaking wave arriving; up to three main pulses were seen. Many smaller pulses of the tsunami continued to affect the area for several hours after the main event. In Burin Harbour, which is quite deep, the tsunami tended to be seen as a very rapidly rising sealevel over about a five to ten minute period, then the sealevel rapidly fell over the same period. Sealevels rose so rapidly that witnesses are reported to have cried out "the land is sinking". It is this very rapid apparent change in "the tide" that gives rise to the erroneous term 'tidal wave'. This term, though incorrect, is the universally-used term in Newfoundland by the people who experienced the event and the term 'tidal wave', as the popular term, was used in all press reports; it has been used in virtually all popular writing since.

The tsunami with its three successive pulses arrived during a high astronomic tide. To make matters worse, the three main pulses arrived over about a half-hour period near the top of a rising (extra high) 'spring tide' or during "the springes" (Figures 7 and 8). Fortunately it was a bright moonlit and a windless evening; the sea was dead calm, thus there were no storm waves to do extra damage. In addition, the tsunami's arrival in early evening meant people were up and about and awake to save themselves. Only the very old and very young were really at risk. In Port au Bras eleven houses were floated off their foundations and seven persons were lost (Ruffman and Hann, in preparation); three of these were children, three were senior citizens; however the loss of life was confined to only four houses.

While a very fierce storm had swept up the eastern seaboard of the United States that Monday afternoon and was just entering Nova Scotia as the earthquake struck, there was no hint of the storm in Newfoundland on the evening of November 18, 1929 (Ruffman *et al.*, in preparation a; b). Indeed, this winter storm did not arrive on the Island of Newfoundland until about daybreak the next morning (Tuesday, November 19, 1929). The storm brought snow and miserably cold weather to further compound the miseries of the residents of the south coast of the Burin Peninsula who were still attempting to comprehend what had happened the night before.

Figure 7

Plot of the November 1929 hindcast astronomic tidal predictions for North Sydney, Nova Scotia showing that Atlantic Canada was experiencing a series of 'spring' tides on November 18-19, 1929. The hindcast tidal predictions were kindly produced by the Tidal Division of the Canadian Hydrographic Service at the Bedford Institute of Oceanography.

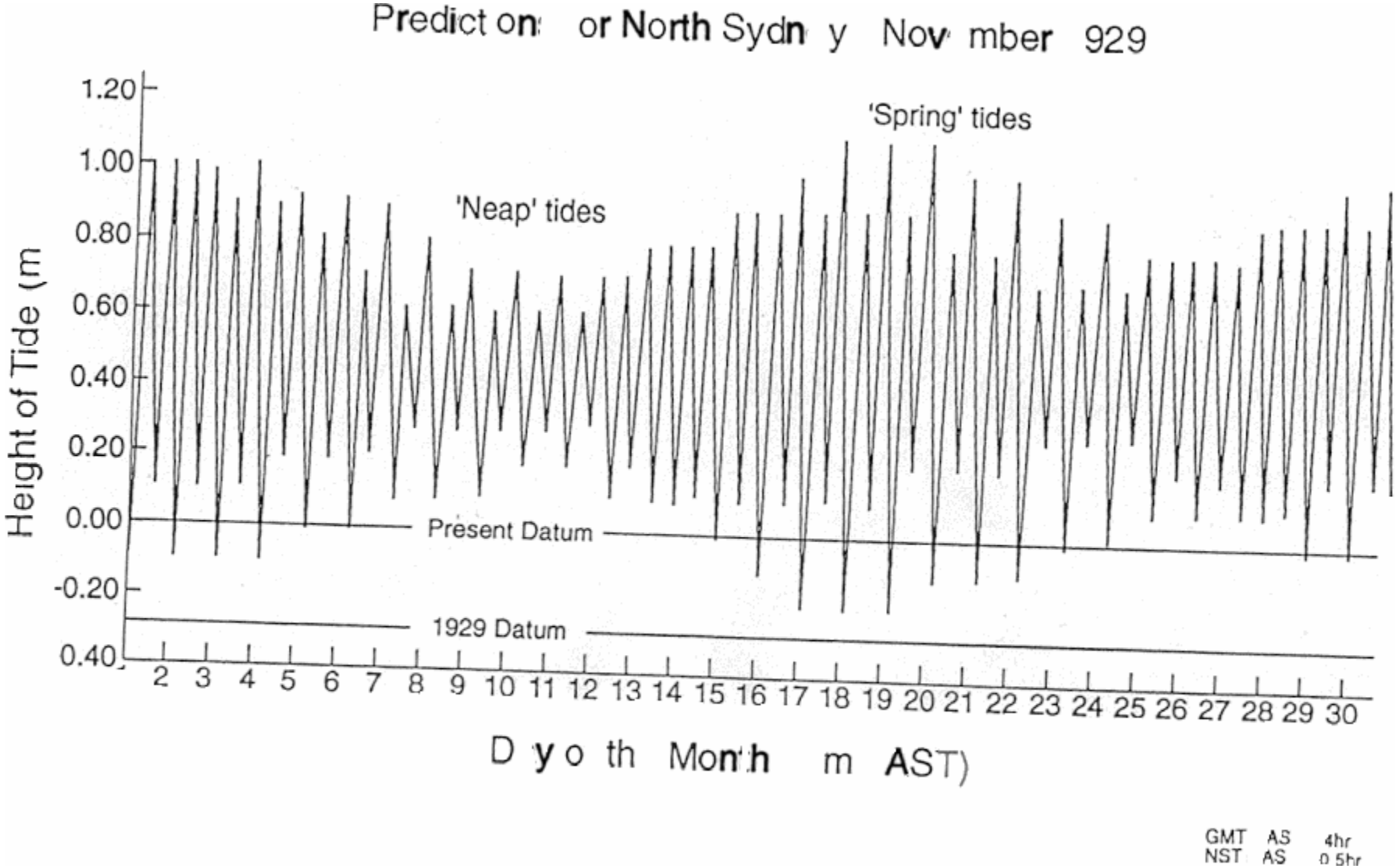
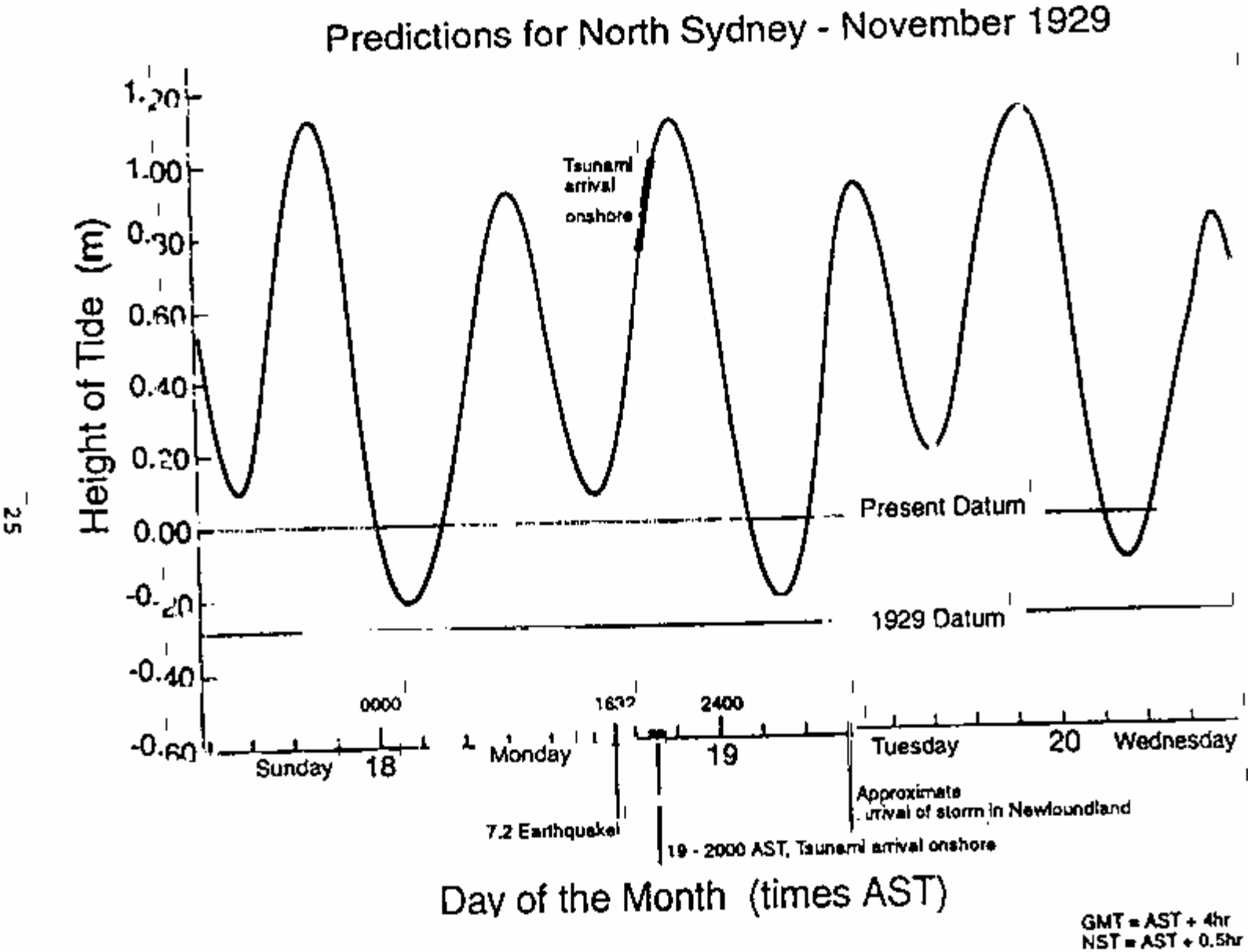

Predict on: or North Sydn y Nov mber 929
'Spring' tides
'Neap' tides
Present Datum
1929 Datum
Height of Tide (m
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
0.40
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
D y o th Mon h m AST)
GMT AS 4hr
NST AS 0 5hr

Figure 8

An enlarged portion of the hindcast astronomic tidal prediction curve for November 18 and 19, 1929 for North Sydney, Nova Scotia. The solid black zone near the top of the rising diurnal tide marks the half-hour-long period when the main three pulses of the tsunami arrived on the Burin Peninsula. The times are Newfoundland Standard Time (NST = AST + 0.5 hr).

The broad and deep low pressure system that accompanied this major November 18-19, 1929 storm brought with it a significant storm surge. The storm surge arrived at the time of the normal monthly 'spring' diurnal tides (the 'springes' — Figure 7). This was such that the normal diurnal high tide at about 1000 NST of the morning of Tuesday November 19, 1929 in Newfoundland was significantly higher and flooded onshore much farther that normal. Many people in Newfoundland who lived away from the south coast in 1929 remember this storm surge on the morning of Tuesday November 19, 1929 as their personal observation of the 'tidal wave' not realizing that the tsunami had long departed the area by daylight on the morning of November 19, 1929.


Predictions for North Sydney - November 1929
Height of Tide (m)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
Tsunami arrival onshore
Present Datum
1929 Datum
0000
1632
2400
Sunday 18
Monday
19
Tuesday
20
Wednesday
Approximate arrival of storm in Newfoundland
7.2 Earthquake!
19 - 2000 AST, Tsunami arrival onshore
Day of the Month (times AST)
GMT = AST + 4hr
NST = AST + 0.5hr

The first positive pulse of the tsunami at about 1940 NST arrived on a rising 'spring' tide just past half tide (Figure 8). While there was no tide gauge in Newfoundland in 1929 it is known from the past 50 years of data that the tidal predictions for Halifax (a principle port) or for North Sydney and Saint-Pierre (both secondary ports) closely mimic those one would hindcast for 1929 for the Burin Peninsula; at worst, there may be very minor amplitude and phase differences. The plots of Figures 7 and 8 for North Sydney in Nova Scotia and those for the community of Saint- Pierre on the islands of Saint-Pierre et Miquelon are also valid for the Burin Peninsula.

Almost all reports of witnesses indicate that the sea withdrew first and that the harbours went dry to start. For those who were outside their homes, the withdrawal gave fair warning of the positive pulses that were to come. Many though were inside on a cold evening and had little to no warning. It is fortunate that the tsunami arrived during waking hours for most or else the loss of life would have been much worse.

In some harbours three major pulses were clearly seen. For example, in Port au Bras, near Burin, the fishing schooner BONAVENTURE which had anchored just at the mouth of the harbour, with a riding lantern hung on its mast, was seen to drag its anchor first in, then out of the harbour, three times. In other communities only two pulses were recognized. In St. Lawrence two major waves are always reported, and three major waves are documented by some, such as Cusick (circa 1994).

Muriel Isaacs wrote in a 1977 article on Port au Bras in *The Post*, which was an insert of *The Daily News*, (Isaacs, 1977):

> **A witness said the tide was unusually high [that day] but nobody placed any significance on it. Then about 8 o'clock, a change took place. The water drained completely out of the harbor and dories, schooners and boats keeled over on their sides. People ran out of their homes as the wave came from the south, carrying everything before it. The exposed coastline from St. Lawrence to Lamaline felt the force of it.**
>
> **The first wave was only the beginning - two more followed with equal intensity. The noise was deafening as large buildings crumpled like matchsticks.**
>
> **People fled to the hills and but for this, the loss of life would have been greater.**
>
> **When it was over and the people came down from the hills - what a sight met their eyes.**
>
> **The moon was shining brightly, the water calm, but the waterfront was a shambles, the harbor right out to the gut was filled with debris. Houses were floating, with kerosene lights still burning and supper dishes still on the table. Stores where people usually kept their winter provisions and fuel had all been swept away, and most tragic of all - the loss of seven lives, four from one family.**
>
> **As Newfoundlanders are wont to do in times of great danger, the men of the community rallied together and that night many lives were saved and many heroes born.**

When dawn broke next morning, the scene was again changed. To add to the misery, the weather had changed. A strong east wind blew and it started to sleet and snow. The wind had cleared the harbour of all debris but with it had gone the winter supply of food and fuel and most people were left destitute. ...

It was the beginning of the leapyears[sic = lean years], added to that was the shock and grief which remained with the people, and a never to be forgotten terror of the night the sea came in. Today 48 years later, it still remains vividly in people's minds.

[p. 17]

Ena Farrell Edwards (1983) tells a similar tale for St. Lawrence, though we note that her writing appears to incorporate a number of factual errors and is clearly mainly derivative in nature (eg. the final paragraph below is taken from Muriel Isaacs' 1977 article almost verbatim and without credit):

... Then, about 8 o'clock, things began to happen. The water drained completely out of the harbour and boats reeled over on their sides, a strange sight indeed. Then came the first wave, a wall of water thirty feet high. Receding, it met an incoming wave and returned with increased violence to the land, to be followed by a third and final wave. The noise was deafening as fishing stages, flakes and stores left their foundations and swept out through the harbour. Many people evacuated their homes and fled to the safety of higher ground. In less than thirty minutes the sea had done its worst. Scenes of destruction and desolation were everywhere. People viewing their destroyed homes, ruined fishing gear, premises, boats and property were dazed and unable to realize fully the nature of the ordeal they had passed through.

... The fishing grounds were swept clean of marine life and it was more than a decade before fishing in the area returned to normal.

It was the beginning of the lean years, and the people of St. Lawrence and the nearby areas were left with the "never to be forgotten terror" of the night the seas came in. [p. 39]

Douglas Hillier of Point au Gaul (son of Manuel and Elsie and one of eight siblings) was a lad of eight at the time of the 'tidal wave'. He recently put his recollections into print via an article by Bonnie Ayers entitled *The day the sea swallowed the land* in *The Southern Gazette* of Marystown on November 14, 1989:

"At around 4 p.m. in the afternoon there was quite a tremor, a real shock. The ground vibrated, the buildings shook; everything was rattling, dishes were falling. And then there was an old gentleman, a Frenchman he was. he knelt down and put his head to the ground and he listened to the tremor.

"Sometime between then and 5 p.m. he reported to the community that we were going to have a tidal wave, but he wasn't sure at what time. At approximately 7 p.m. that same evening the tidal wave had started."

... "We didn't know what a tidal wave was so most people never thought much of what the old man said."

... "It was a beautiful day, a little bit chilly but sunny, just a beautiful day with a very light wind."

WARNING SIGNS

When the tremor hit, which Hillier says lasted about a minute, there were some horses, about 20, out on the point (piece of land jutting out into [the] cove). "They all walked in, it was a distance of about one mile. They just came in. They seemed to know something was wrong, that there was danger." (He noted it was a seldom sight to see the horses do such a thing as the pasture there offered a good grazing area.)

He said a lot of sheep also congregated in a neighbour's yard. It was a common sight, but not that early in the day. "They knew there was something happening and the few horses which were loose in yards took off for the hills. Wherever there was high land, that's where they seemed to go."

The moon was glowing brightly in the sky when Hillier says he was in his home looking out the window and saw the white foamy wall, almost a quarter mile wide, bearing down on the community. (Most of his family had gone back to the house when the tremor was felt.)

WALL OF WATER

"We happened to look out the front window and when we did here's this big wave and here's a trap skiff coming with it all the way up the road just like someone was sitting in it and steering it, straight up the road. It stopped at the side of the main road." ...

Hillier said he can remember six to eight waves pounding the shore and homes. "Each one came as fast as the one before it."

When it was finally over the water (tide) in the cove went out around 5,000 feet, the lowest it had ever gone. ...

Hillier believes that since the tidal wave struck the marine life in the area has continued to decrease along with the land along side the beach through erosion.

Today the point is an island and can only be reached during low tide with the assistance of a sand bar. Nobody has lived there since 1929. [p. 7]

The S.S. PORTIA, with Captain W.B. Kean in command, was the first vessel with a radio and a radio operator to arrive in the stricken area early on Thursday, November 21, 1929. The single telegraph line linking the Burin Peninsula to the main island and St. John's had gone out of

service in a storm on the weekend before the Monday, November 18, 1929 earthquake and tsunami. Thus the Burin was on its own, cut off from St. John's, and with most communities cut off from each other. In Taylor's Bay, Jacob Bonnell's floating house had tangled in the telegraph wire, while in St. Lawrence, the telegraph office ended up anchored in the harbour. In Lord's Cove, the telegraph office was destroyed completely (*The Daily News*, St. John's, Friday November 22, 1929, p.3, cols. 7 and 8). Indeed the whole of the stricken 'South Coast Disaster' area was on its own till the morning of Thursday November 21, 1929 — 2½ full days.

The S.S. PORTIA came into Burin on its regular coastal run on Thursday morning and sent a notice of the disaster by wireless to St. John's. Captain Kean wrote in a letter to *The Evening Telegram* in St. John's, in part (Kean, 1929):

> **For the benefit of those who have not visited Burin, I may say the Harbor is approached through a channel lying between two perpendicular cliffs on the west side. Those cliffs are so steep and meet the waterline at such an angle that it is impossible for building purposes. The channel is therefore usually quiet and empty, apart from the usual boat or vessel that is met in passing.**
>
> **MET BY FLEET OF FLOATING BUILDINGS**
>
> **Imagine our wonder and surprise on turning the point of the channel to be met by a large [fishing] store drifting slowly along the shore seaward; then a short distance another store or a dwelling house until 9 buildings were counted, strewn along the shores before the harbor was reached. On reaching the harbor even a worse spectacle greeted the eyes.**
>
> **AN AMAZING SPECTACLE**
>
> **The sight of the whole thing as it appeared from the deck of the "Portia" on that eventful morning, to say the least, was weird in the extreme, and all eyes were fastened on the waiting group of men on the shore to learn the truth of what had happened. [p. 7]**

Most estimates of the day suggested that the 1929 tsunami elevation was 30 to 50 ft high (9.1 to 15.2 m). In fact, it is doubtful that the tsunami elevation reached more than about 7.5 m above the normal calm sea of that still moonlit evening. While precise levelling has only been carried out at one location (Taylor's Bay), earlier field work done by the author in 1989 suggested an elevation rise of about 4.6 m in Burin and Port au Bras, about 3 m in Lamaline and Point au Gaul and perhaps as much as 7.5 m in Taylor's Bay; no estimate has been determined for Lord's Cove.[5] Rudimentary levelling in Taylor's Bay during the 1993 reconnaissance program used the relocated foundation 'shores' of the Leo R. Bonnell home and this work suggested that sealevel rose 7.0 m on the western side of Taylor's Bay during the 1929 tsunami. The 1994 field work has confirmed a tsunami height of about 7.5 m on the west side of Taylor's Bay. The present beach bar at Taylor's Bay is only about 2.3 m high relative to the level of the astronomic tide at the time of the tsunami.

It is clear that at least one of the tsunami waves in almost every Burin Peninsula locality broke and advanced as a foaming white "wall of water". I remember Lou Etchegary, as a 64-year-old engineer, describing to me in circa 1985, his memories of this wall of foaming water lit up by the full moon. His words, drawn from the first-hand experience of an eight-year-old boy in St. Lawrence were, "It was like the headlights of a car coming down the bay."

The 'runup' from the 1929 tsunami often carried to somewhat higher elevations than the elevation of the tsunami wave itself, especially off the north ends of the various inlets. There are some data available to assist one to judge, and in some cases to measure, the tsunami runup but no levelling has been done to date other than at Taylor's Bay. A stake was driven in the bank at Port au Bras by one resident in 1929 to mark the maximum height of the tsunami as it rolled up the harbour. In another spot, fish are known to have been stranded near the Anglican Church in Port au Bras. In Burin, the wall of a building on the main wharf was marked at the time to show the water level of the tsunami, though that building is now gone. In Sydney, Nova Scotia, a similar mark was noted and later it was levelled in.

William H. Berninghausen (1968) notes over 30 locations in five countries where the tsunami was visually seen (Canada, United States, Newfoundland, Bermuda and France (Saint-Pierre et Miquelon just off the south coast of Newfoundland, just west of the Burin — Figure 2)), though in the United States the only visual record appears to be on tide gauges. Berninghausen used first-hand observations of the tsunami and data from tide gauges to draw the travel time curves seen on the map in Figure 6. Tad Murty (1977, p. 267) also gave an areal plot of calculated travel time curves for the tsunami based on model work using the known bathymetry in the area off southern Newfoundland and to the east of Nova Scotia (Figure 9). Tide gauges in the Azores and in Portugal also recorded the tsunami (Ruffman *et al.*, in preparation b).

The records of the South Coast Disaster Fund Committee [later known as just the South Coast Disaster Committee] note, in a December 5, 1929 memo, a list of the 23 communities then-reported to have been 'directly affected' by the tsunami. This December 5th memo then further adds List No. 2 of the communities 'within the area stricken by the disaster, and which no doubt suffered to some extent as a result of it' and expands the list to 43 settlements. Ultimately claims for compensation came in from most of these communities (South Coast Disaster Committee, 1931).

Many of these claims were for lost fishing gear, fish stores (a building on a wharf or shoreline where fish are processed and stored), wharves, flakes and vessels from schooners to dories and flats. There was also some compensation for injuries and for the 27 deaths then-associated with the tsunami. The author and Violet Hann of Mount Pearl, Newfoundland have been developing a slightly revised and significantly updated death list that puts the tsunami death toll at 28 persons.[6] We have added a child to our list from Taylor's Bay, who did not die of her injuries until the Spring of 1930, but well within the one year generally allowed by modern-day coroners for deaths attributed to a particular event (Ruffman and Hann, in preparation).

The Burin coast learned a tragic lesson the night of November 18, 1929, one that had not been taught by the sea in such severity since the hurricane of September 11-12, 1775 (Stevens and Staveley, 1991; Ruffman, 1995; 1996). That lesson is to respect the sea and to not build too close to the edge of the sea no matter how convenient it is to move one's gear to and from the fish store. In fact, the families of the communities along the Newfoundland coast in 1929 had built many dwelling houses and fish stores far too close to the shoreline and often just above sealevel.

It was very common in the 1920's and earlier to drive in wooden pilings (known as 'shores') down into the peat of a 'meadow', or into the beach material, and to build a building up off the wet ground and above the occasional high spring tide (the 'springes'). Certainly a number of the dwelling houses in Lamaline, Port au Bras, Kelly's Cove, Taylor's Bay, Point au Gaul and St. Lawrence which lifted off during the tsunami had been built very close to sealevel and very close to the shoreline. Mr. William Cake, of Lamaline East (Muddy Hole), has a painting of their home before the tsunami lifted it off its pilings. The painting shows the shores in the 'landwash', or tidal zone, beneath the front of the house. I spoke to Mr. Cake in 1989 who stated that on occasion the sea came up under the seaward side of the house and washed among the seaward shores. On the night of November 18, 1929 the Cake house in Lamaline East (still known as Muddy Hole) floated, lifted off the pilings, and then was deposited quite close by (1989 interview notes and taped interview done by Alan Ruffman). The same fate beset the Hepditch home on 'the Point' of Lamaline East with Mrs. Linda May Hepditch (née Bonnell) and her sons Bill and Stanley still aboard. Luckily no lives were lost to the 1929 tsunami in Lamaline. The 1929 tsunami, while not large by Pacific standards, or even when compared to the tsunami

Figure 9

Tad Murty's 1977 text and his model estimates of the travel-time curves for the November 18, 1929 tsunami. The cited estimates of the tsunami heights of "at least 12.2 m" and "30.5 m as the maximum amplitude in Burin Inlet" are highly unwarranted. These exaggerations and an apparent time error may indicate that Murty's derived isotravel-time curves should be reexamined. It is not anticipated that the shape of the curves would change in that the deeper water of the wide Laurentian Channel that runs NW-SE between Cape Breton Island and Newfoundland allowed the tsunami waves to pass to the northwest with less loss of forward speed.

Thus the tsunami arrived in Sydney, Nova Scotia about half an hour after it arrived along the southern coast of the Burin Peninsula. The tsunami took 2.5 hours to reach the Burin Peninsula and a little longer to affect Cape Breton Island.

Excerpt from page 267 of Murty (1977)
giving a plot of the theoretical travel time curves
for the November 18, 1929 tsunami
on a map of Atlantic Canada

Note: Murty's time of 0432.8 NST in the text below as the time of the earthquake is incorrect. The earthquake occurred at 1632:00.2 AST, or at 1702.00.2 NST.

Contrary to popular belief, the eastern part of Canada is also seismic and has indeed produced tsunamis. Milne (1967) stated that severe earthquakes can occur in the St. Lawrence Valley, in the arctic, and near Newfoundland. The so-called Grand Banks earthquake occurred on Nov. 18, 1929, in the Atlantic Ocean, southeast of Newfoundland. The epicenter was at 44°30'N, 57°15'W and the time of occurrence was 0432:8 (Newfoundland Standard Time). The turbidity currents following this earthquake caused numerous cable breaks in the Atlantic Ocean.

This earthquake generated a tsunami with amplitudes to at least 12.2 m (Johnstone 1930) in Burin Inlet on the south coast of Newfoundland and killed 26 people. Gregory (1929) gave 30.5 m as the maximum amplitude in Burin Inlet. McIntosh (1930) gave a value of 4.6 m for the tsunami amplitude at Lamaline. According to Johnstone, no tsunami was observed at Sable Island, probably because the island was well protected by sandbanks. Although the tsunami waves were considerably amplified in a northerly direction (i.e. in the direction of Newfoundland), they were not significantly amplified in a westerly direction as can be seen from the water-level records on the Canadian and U.S. east coasts. At Halifax, the amplitude was only 0.5 m and at Atlantic City the amplitude was 0.3 m. Murty (1975) explained the nonamplification westward as due to the orientation of the fault in a east-west direction. Murty and Wigen (1976) studied this tsunami in detail and showed that resonance in the V-shaped Burin Inlet accounts for the great amplification of the tsunami in that inlet. Figure 5.43 shows the travel-time curves for this tsunami and it can be seen that the tsunami energy traveled preferentially toward the south coast of Newfoundland.

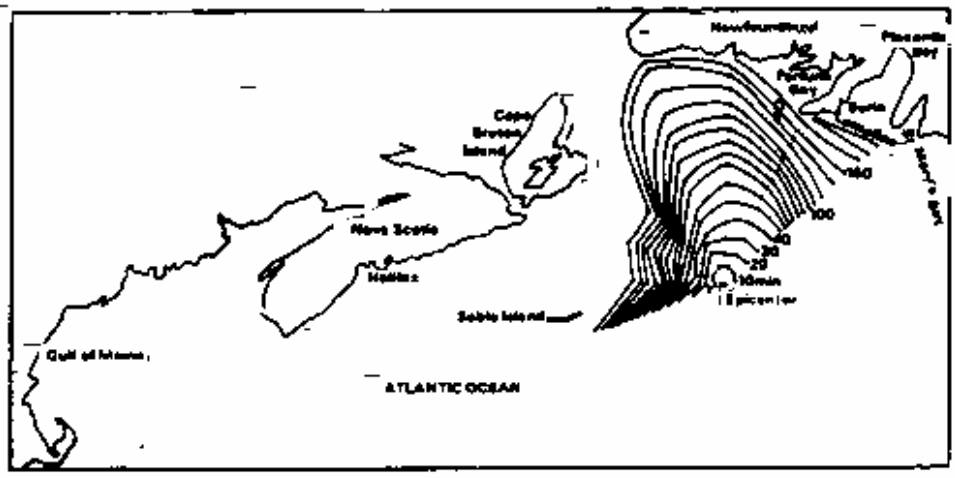


FIG. 5.43. Travel-time curves for the Grand Banks earthquake tsunami of Nov. 18, 1929.

caused by the 1755 Lisbon Earthquake, or to the c. 7,000-year-old proposed Storegga event of Dawson *et al.* (1988) and Long *et al.* (1989a; b), nonetheless was devastating to the lives and to the economy of the south coast of the Burin Peninsula. It came at the beginning of a worldwide depression and at the beginning of a widespread collapse of the bait fishery for squid, herring and capelin hence a collapse of the cod fishery both inshore and on the Banks (Ruffman *et al.*, in preparation b). These external factors compounded the difficulty that the communities on the Burin had in recovering and some, such as Taylor's Bay, have never recovered.

Perhaps we should leave the postscript to a Lillian Walsh, who was possibly a child of Point au Gaul or Nantes Cove parents, who were, by 1929, living in Sydney, N.S., in Canada. Ms. Walsh wrote a poem "The Waters of Burin" that was printed as a broadsheet and which was found by the author in 1989 pasted into the scrapbook of Helen Darby of Collins Cove (Mrs. Darby was the telegraph operator at the now-abandoned community of Great Burin, out on the island of Burin, when the three waves of the 1929 tsunami arrived and wrecked their harbourfront). Lillian Walsh wrote (circa 1930) in part:

It is the date of the earthquake, and a tidal wave at sea,
And cries of women and children were heard above the roar
Of the rushing, turbulent waters that swept the Burin shore.

Neath Burin's swollen waters, that dark November night,
Twenty-seven persons lost their lives before the morning light,
Women and little children, men that were strong and brave,
Were swept away in their little homes and drowned by the tidal wave.

Now saddened and discouraged, their means of living gone,
The fishermen walk their native shores, searching the beach along,
Watching closely the harbor, where the boats at anchor ride,
Maybe the form of some loved one will be cast ashore by the tide.

Stooping to pick up the driftwood, once a part of their home,
Or part of a flake or a fish-house, half buried in sand and foam,
Flinging it down in the land wash, to be taken again by the tide,
Then searching again for the bodies that the waters of Burin hide.

Only men that sail the ocean blue can fully understand
The perils of a fisherman's life round the shores of Newfoundland,
But human hearts the whole world o'er can sympathize with them
That lost their loved ones and their homes when the waters swept Burin.

TSUNAMI HEIGHT OR AMPLITUDE VERSUS RUNUP HEIGHT

The excess height of the 1929 tsunami over the normal high, astronomic, 'spring' tide of the evening of November 18, 1929 (Figure 8) is difficult to know exactly. There were no tide gauges operating in Newfoundland and only the Halifax tide gauge record is available; it tells us nothing about the tsunami amplitudes in Newfoundland. The amplitude of a tsunami, as it arrives at the shoreline, very much depends upon the local shoreline geometry and the local bathymetry or water depth. Thus the worst situation to be located in, when the tsunami arrived in 1929, was at the head of a long narrow bay that funnelled the tsunami's energy into an ever-rising wave of higher and higher amplitude until it broke. Port au Bras had particularly bad geometry as did Lansey Barque, Lawn, Little Lawn Harbour and Taylor's Bay. The geometry at the mouth of St. Lawrence Harbour along with a protruding beach and point on the west side (Blue Beach and Blue Beach Point) was such that the tsunami lost some of its energy and hence probably some of its amplitude before it entered the main harbour (Figure 10).

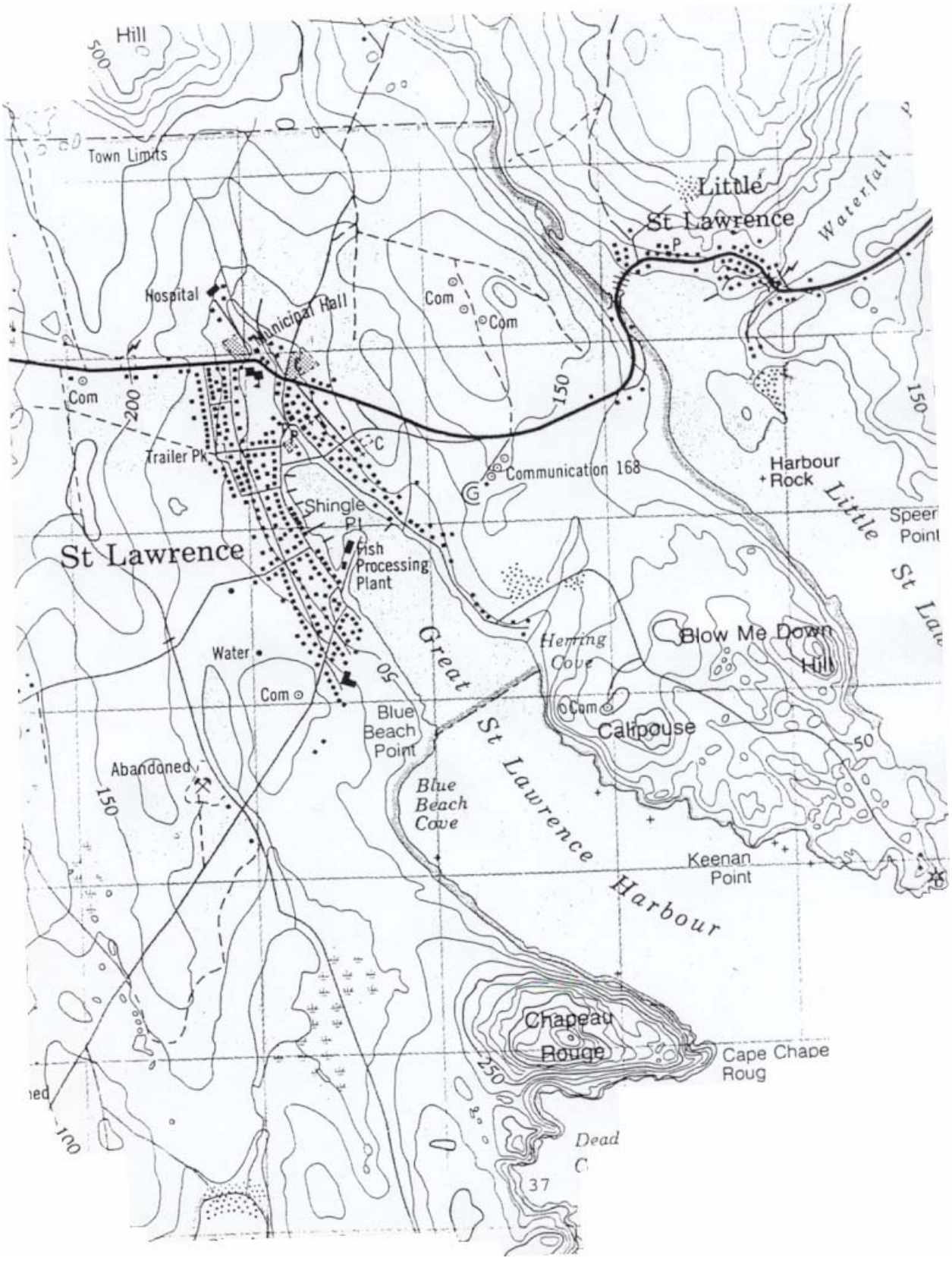
The tsunami's height over and above the high, astronomic, 'spring' tide that night is referred to as the 'tsunami height' or amplitude in this report.

A tsunami wave also has considerable energy or momentum as it arrives at a shoreline. If the shoreline is a cliff, the wave will just reflect and go back out to sea. However, if the shoreline is, for example, a low, flat, barrier beach with a back-beach pond and a broad, low fringing peat bog or marsh area, the tsunami's momentum can carry it a considerable distance inland before its rise against gravity takes its energy and it must flow back to the sea. This distance from the normal high tide line is called the 'runup distance'. The elevation to which the tsunami's momentum carries it is the 'runup height'. The runup distance for the 1929 tsunami was as much as one to two kilometres in places like Taylor's Bay and Little Lawn Harbour.

The tsunami runup height and distance are often confused by observers of a tsunami with the tsunami height; indeed, the tsunami height is difficult to estimate unless an observer is at a wharf watching a tied-up vessel rise and fall with the tsunami wave (eg. at the Burin government wharf on November 18, 1929 where the S.S. DAISY was observed to rise well above the wharf before falling). In 1929 no post-tsunami surveys were done of the runup zone, or of the zone of inundation, and no first-hand information was gathered on the tsunami height. All the information we have comes from oral history gathered mainly by the author since 1989.

Figure 10

An enlarged portion of the current 1:50,000 topographic map for the St. Lawrence area. The contour interval is 50 ft. The map was made from a set of 1981 aerial photographs (Canada Department of Energy, Mines and Resources, 1988). The scale of the map as shown here is about 1:26,050. The darker shaded area is wooded land; the rest of the area is virtually barren.


Hill
500
Town Limits
Little
St Lawrence
Waterfall
Hospital
Municipal Hall
Com
Com
Com
150
200
150
Trailer Pk
Communication 168
Harbour
Rock
Little St Lawrence
Speer
Point
Shingle
Pt
St Lawrence
Fish
Processing
Plant
Water
Com
Great St Lawrence Harbour
Herring
Cove
Blow Me Down
Hill
Com
Calipouse
50
Blue
Beach
Point
Abandoned
150
Blue
Beach
Cove
Keenan
Point
Chapeau
Rouge
Cape Chape
Roug
250
100
Dead
37

ST. LAWRENCE, NEWFOUNDLAND IN 1929

The community of St. Lawrence was a fishing village of about 800 persons in 1929,[7] comprising about 135 families (census of 1935). It was entirely dependent upon the fishery, with a small amount of outside trade with places like Saint-Pierre et Miquelon. Almost every family had a wharf, a fish store and a fish flake on which to dry fish, with all building shores and poles ('sticks' and 'longers'), lumber and firewood cut locally from the land.

In 1929 there were probably no vehicles owned locally, and there was no road connection eastward the short 20 km distance to Lewins Cove, Marystown and Burin; there was only a footpath to Corbin and on to Epsworth and Wandsworth, then a small ferry connected across the inlet to Burin. Similarly, not much more than a track led westward to Little Lawn Harbour, Lawn, Lansey Barque, Roundabout, Lord's Cove, Taylor's Bay, Lamaline, Point May, Point Crewe, eventually to Grand Bank where an early road led around the north side of the Peninsula back east to Marystown (Figure 2). A 1937-41 album of photographs was found archived at the St. Lawrence townhall. These images were taken by Albert J. Wallace[8], the mine manager of the E.J. Lavino & Co. fluorspar mine. The album's final photograph is of a car on a narrow rutted road with a large dog towing a cart[9] and a caption reads, "St. Lawrence to Burin by boat 12 miles; by land 100 miles. Enroute Grand Bank to Burin May '39". In 1929 communication between the villages was by small boats and via the scheduled coastal ferries.

There was telegraph communication between the communities by 1929, and a single wire connected the Burin Peninsula villages north from the Marystown area, over the barrens, to St. John's. This was an intermittent and fragile connection at best in bad weather. There were no regular wireless radio communications, save on a few of the coastal ferries (if a qualified operator was on hand). The S.S. DAISY, which was in port in Burin during the tsunami, apparently carried a wireless radio but no-one could operate it (W.J.S., 1929; MacFarlane, 1969). Electricity had just been made available in St. Lawrence and Lawn in 1929 but few families could afford the service.

Life was hard for many families in St. Lawrence in 1929, and it was to get harder after the November 18, 1929 tsunami, with the failure of the fishery that followed hard on its heels, and with the worldwide depression that dominated the early 1930's. Mr. Stephen Cusick has written of this hardship in his 19-page unpublished manuscript 'Fight For Survival' (circa 1994) which was kindly supplied to the author by his son and daughter-in-law, John and Emma Cusick of Herring Cove on the east side of St. Lawrence. Mr. Cusick apologises for his spelling; "I only got to the right grade of three, Number 3 Royal Reader it was call[ed] then, that's the name of the book." — but his words more than capture the difficulty of the times:

> **Well like I said my father was a fisherman but he never had any amount of fishing gear. Just a few lines of trawls and you needed a lot of fish at that time to get any money. For 200 lbs of number one sun cured fish was only worth $250 (that's dry salt fish). So you had to have a lot of fish to get any money. After a while my father went Bank fishing out of Lunenburg, Nova**

Scotia, and my grandmother came to look after us until my father would come home. He used to leave home around the first of April & come home again in November. Well, me & my sister and brother would scrape something to burn as my grandmother had her hip broken one time, and there was no doctors around then. So her leg just grew together and one leg was shorter than the other. She was crippled. She used to spin wool and knit mitts and socks for other people. Well I was still going around in my bare feet, used to go in the woods and bring wood and boughs or limbs from the trees to burn. The bottoms of my feet was almost as tough as the top of a boot. ... [pp. 1-2]

STUDY APPROACH AND METHODOLOGY

The very limited written material was gathered. This consisted of the few relevant newspaper articles on St. Lawrence published at the time, a manuscript history of St. Lawrence, one published collection of anecdotal historical material, and the files of the South Coast Disaster Committee at the Provincial Archives of Newfoundland and Labrador in St. John's.

The town of St. Lawrence is referred to as 'the town without grandfathers'. Almost two generations of men have been killed by the 'miners disease' in the local fluorspar mines. The deadly conditions arose first in the mid-1930's E.J. Lavino & Co. fluorspar mine which opened just west of the town, then in its successor Aluminum Company of Canada (ALCAN)-run mines, and finally in those of Minworth that followed. The dust gave rise to silicosis, and radon-borne radioactivity gave rise to lung cancer (de Villiers and Windish, 1964; Parsons *et al.*, 1964; Government of Newfoundland, 1969; Slaney, 1965 through The Confederation of National Trade Unions, 1975). At the time, Elliott Leyton wrote his moving book, *Dying Hard*, using the words of his interviewees, the dying miners, he started Chapter 1, 'The Carnage', with: "Some one hundred men are dead and another hundred wait an early death in two adjacent villages in Newfoundland's foggy south coast. One household in every three has a dead or dying miner in the town of St. Lawrence and Lawn." (Leyton, 1975) At the time of my field work in February 1995, the figure was estimated by a town council member at 325 men that have died of the miner's disease. Thus the town of St. Lawrence (and nearby Little St. Lawrence and Lawn) have a severely limited number of men old enough to remember the events of November 18, 1929; it has many more women of this age, but I suspect that even these numbers are somewhat reduced through out-migration necessitated by the loss of the male breadwinner and related family support. We used the data from nine taped oral history interviews with older residents; five of these involved women or mainly women.

Tsunami data from the written sources and oral history interviews were transcribed onto 1:2,500 community maps in the field. The maps were also used as an aid during interviews with those interviewees or informants who could relate to maps. These maps became the basis for the two foldout maps of this report and for the two Enclosures in the separate Volume 2-Appendices and Enclosures.

AVAILABLE MAPPING FOR ST. LAWRENCE

There appears to have been no maps of St. Lawrence prior to Confederation with Canada; indeed, there were no air photographs of the community, or of the Burin Peninsula, until just after Confederation. Air photographs of St. Lawrence are available for the following years:

Year	Line No.	Scale
July 12, 1949	A12103	1:34,200
October 14, 1966	A19831	1:50,000
July 28, 1966	A19601	1:15,840
June 23, 1976	A24563	1:30,000
June 14, 1976	A24462 line 1E, 2W, 3E	1:12,000
July 25, 1981	A25811	1:50,000
May 28, 1983	A83006 line 13S, 14S, 15W	1:12,500
May 27, 1987	A87003 line 8S, 9N	1:15,000

The first topographic maps made of the area were published in 1957 and were made from the 1949 air photographs; they were published at the 1:50,000 scale with a 50-foot contour interval. The second edition maps were made from the 1966 air photographs and printed in 1970 (Canada Department of Energy, Mines and Resources, 1970). When the road improvements went through in 1976-77, a third edition of the topographic sheets was printed (Canada Department of Energy, Mines and Resources, 1988) using 1981 air photos, again at 1:50,000 with a 50-foot contour interval. St. Lawrence appears on these sheets with relatively little detail because of the small scale (Figure 10).

There were no detailed hydrographic charts before Confederation with Canada. The Canadian Hydrographic Service (CHS) surveyed the area in the summers of 1952-53 using sextant positioning. Chart 4642, (Canadian Hydrographic Service, 1960, reprinted 1978) was first published of the Lamaline, Great St. Lawrence and Little St. Lawrence Harbours in 1960. The chart of Great St. Lawrence Harbour is at a scale of 1:20,000 and is, of itself, a significant improvement over the 1:50,000 topographic sheet but has little onshore topographic data (Figure 11). The inset map of the inner part of Great St. Lawrence Harbour at 1:6,000 shows even more

detail (Figure 12). Both maps of St. Lawrence shown on the current (1978) version of Chart 4642 have been updated to May 22, 1991, with a pasted-on overlay of corrections as seen in Figures 11 and 12 here.

The Newfoundland government flew the St. Lawrence - Little St. Lawrence areas in 1983 at a scale of 1:12,500, and again the town was flown on May 27, 1987 at a scale of 1:15,000 using Aerial Mapping & Photography Limited (Job No. 87-009). Kenting Earth Sciences International Ltd. were then contracted in 1988 to make up eight 1:2,500 map sheets for what was then the Newfoundland and Labrador Department of Environment and Lands (now the Department of Natural Resources) (Figure 13). These sheets were contoured at a two-metre contour interval based on "mean sealevel" as shown on the photographs on Flight Roll 87003, photos 28-47 (Lines 8S and 9N) (Figure 14). Mean sealevel in fact was taken from annotated photo negative No. 33 or 34 on Line 8S at an interpolated time of 1837 +13.3 seconds GMT (or 1507 +13.3 seconds NST) on May 27, 1987. Thus to compare the elevation datum used on the 1987 map sheets to that shown on the CHS charts, or to the CHS tidal hindcast data from November 18, 1929, one must obtain hindcast tidal data for 1507 NST on May 27, 1987 for St. Lawrence, Newfoundland. These data were requested in early March of 1995, but the Canadian Hydrographic Service has not yet been able to respond.

The 1987-based map sheets at 1:2,500 were used to construct the base map for this project (Newfoundland and Labrador Department of Environment and Lands, 1988). Five of the available 1:2,500 north-south oriented sheets were cut together to form one single NW-SE oriented map that stretched along the Great St. Lawrence Harbour from the entrance at Blue Beach Point to the northwest as far as Highway 220 and beyond to the U.S. Memorial Health Centre (Figure 13, foldout Maps 1 and 2).[10]

Figure 11

Portion of the 1978 (modified to May 22, 1991) Chart 4642 of the St. Lawrence Harbours (Canadian Hydrographic Service, 1960, reprinted 1978). The original published natural scale was 1:20,000; it is shown here at about 1:23,600. Soundings are in fathoms or fathoms and feet, with the feet as subscripts in water of less than 11 fathoms depth. The CHS contours on water depth are drawn at 0, 1, 3, 6, 10 and 20 fathoms and are drawn relative to the CHS 'chart datum'. Polyconic projection. The lighter area at the top is a post-1978 pasted-on modification sheet of CHS.

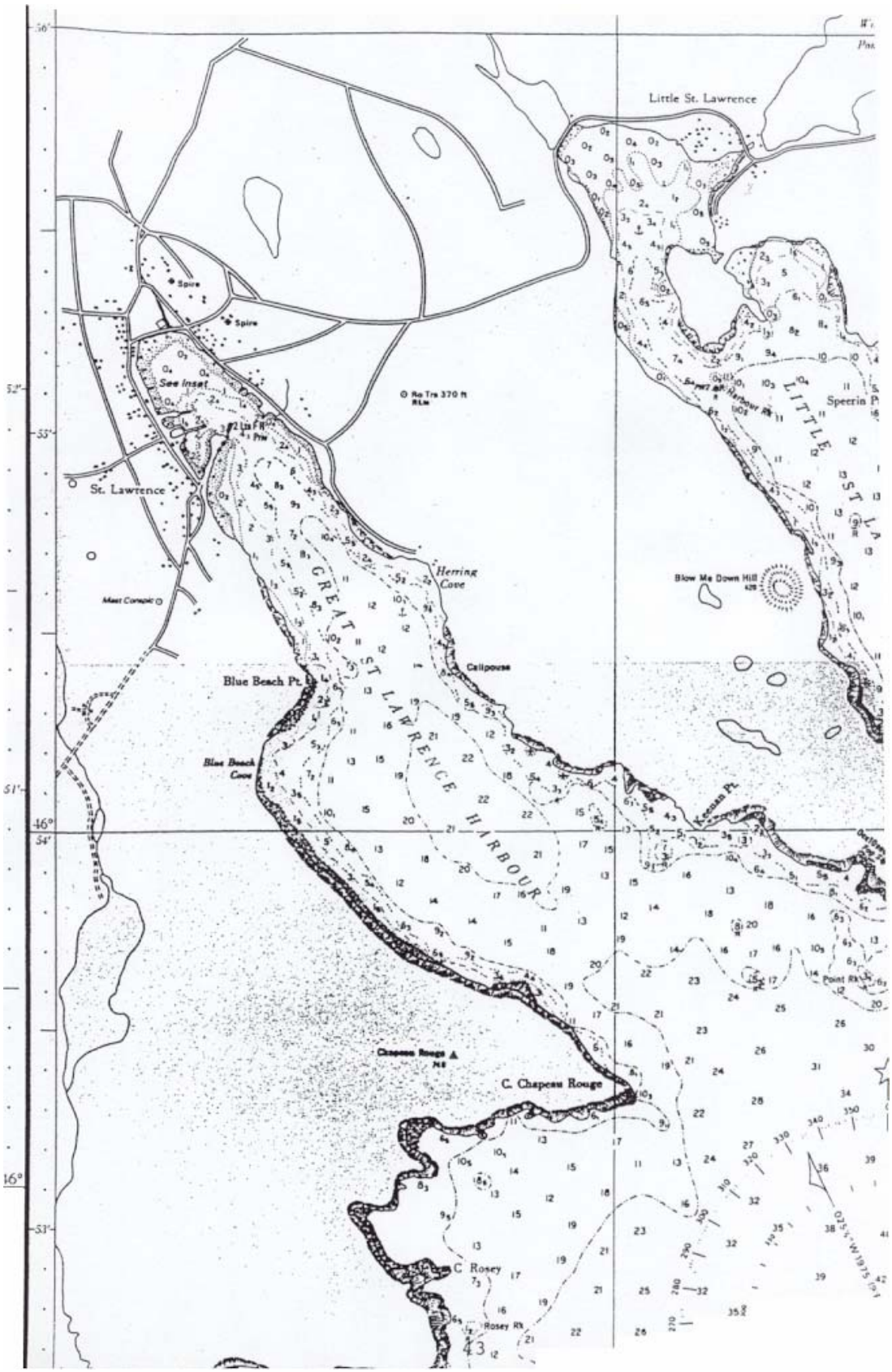
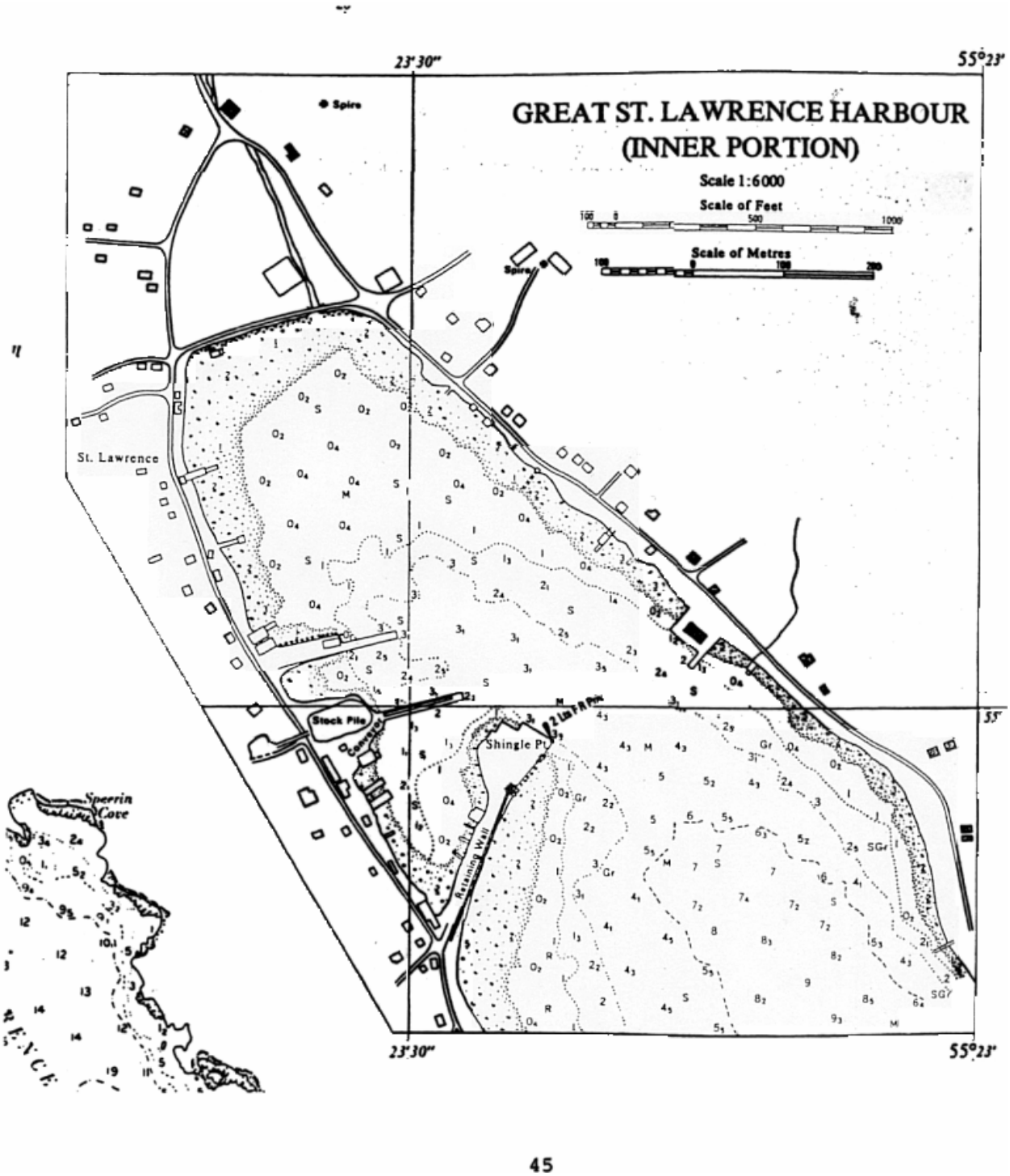

Little St. Lawrence
Spire
Spire
See Inset
St. Lawrence
Herring Cove
Blow Me Down Hill
Calipouse
Blue Beach Pt.
Blue Beach Cove
GREAT ST LAWRENCE HARBOUR
LITTLE ST LA
Speerin Pt
Point Rk
C. Chapeau Rouge
C Rosey
Rosey Rk
46°
16°

Figure 12

Portion of the 1978 (modified to May 22, 1991) Chart 4642 inset map of Great St. Lawrence Harbour (Inner Portion) (Canadian Hydrographic Service, 1960, reprinted 1978). The original published natural scale was 1:6,000; it is shown here at about 1:5,650. Soundings are in fathoms and feet. The CHS contours on water depth are drawn at 0, 1, 3 and 6 fathoms and are drawn relative to the CHS 'chart datum'. Polyconic projection. The lighter area at the head of the harbour is a post-1978 pasted-on modification sheet of CHS. The middle pier on the west side of the harbour was the Alcan Wharf at the time the chart was published and the "Stock Pile" is a pile of fluorspar ore awaiting shipment.


GREAT ST. LAWRENCE HARBOUR
(INNER PORTION)
Scale 1:6000
Scale of Feet
Scale of Metres
23°30"
55°23'
Spire
St. Lawrence
Stock Pile
Shingle Pt.
Retaining Wall
Sperrin Cove

45

Figure 13

Index map at 1:50,000 to the series of eight Newfoundland and Labrador Department of Environment and Lands (1988) 1:2,500 maps of St. Lawrence. The base map for this project was constructed from the maps 1L14-324, 333, 334, 343 and 344.

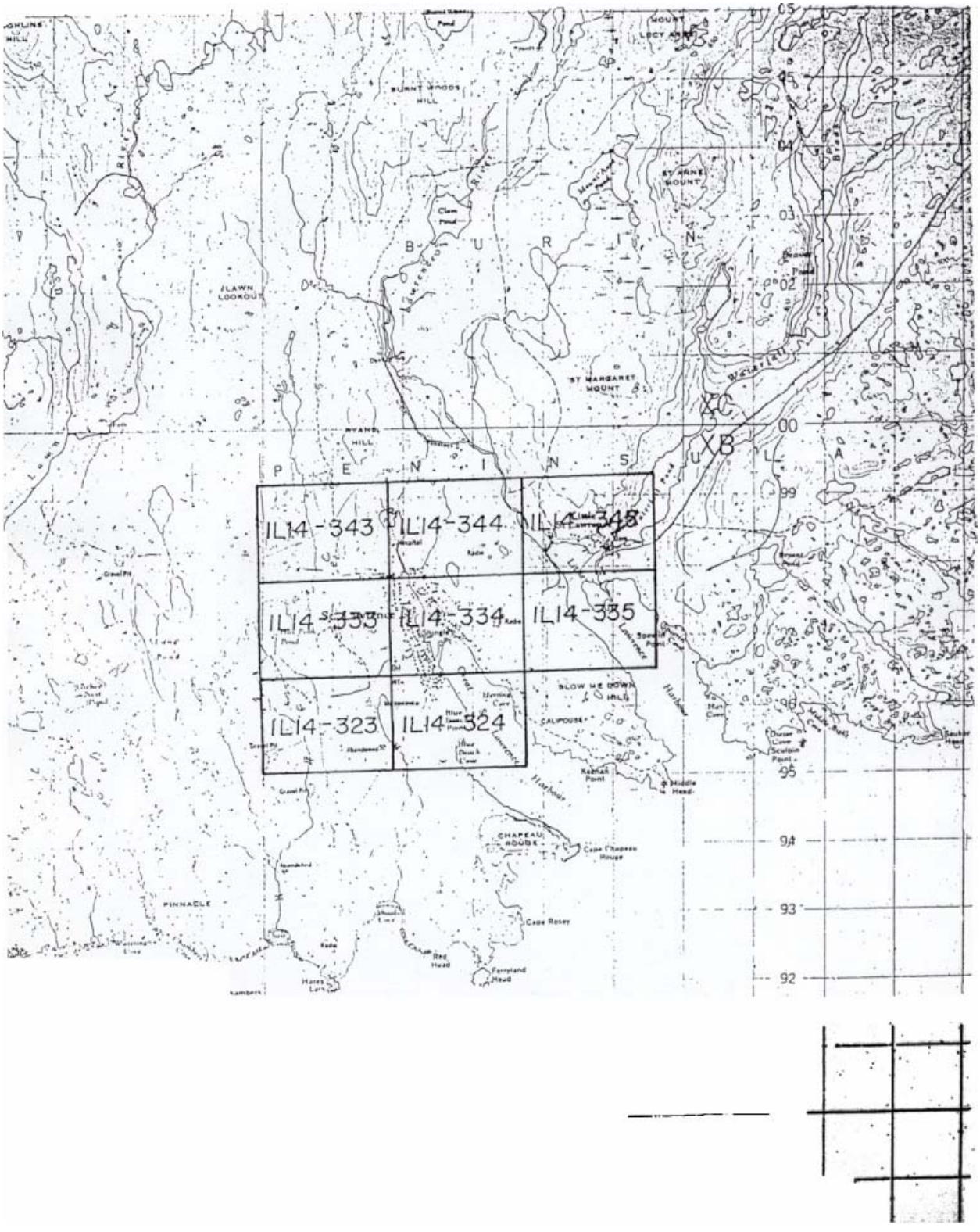
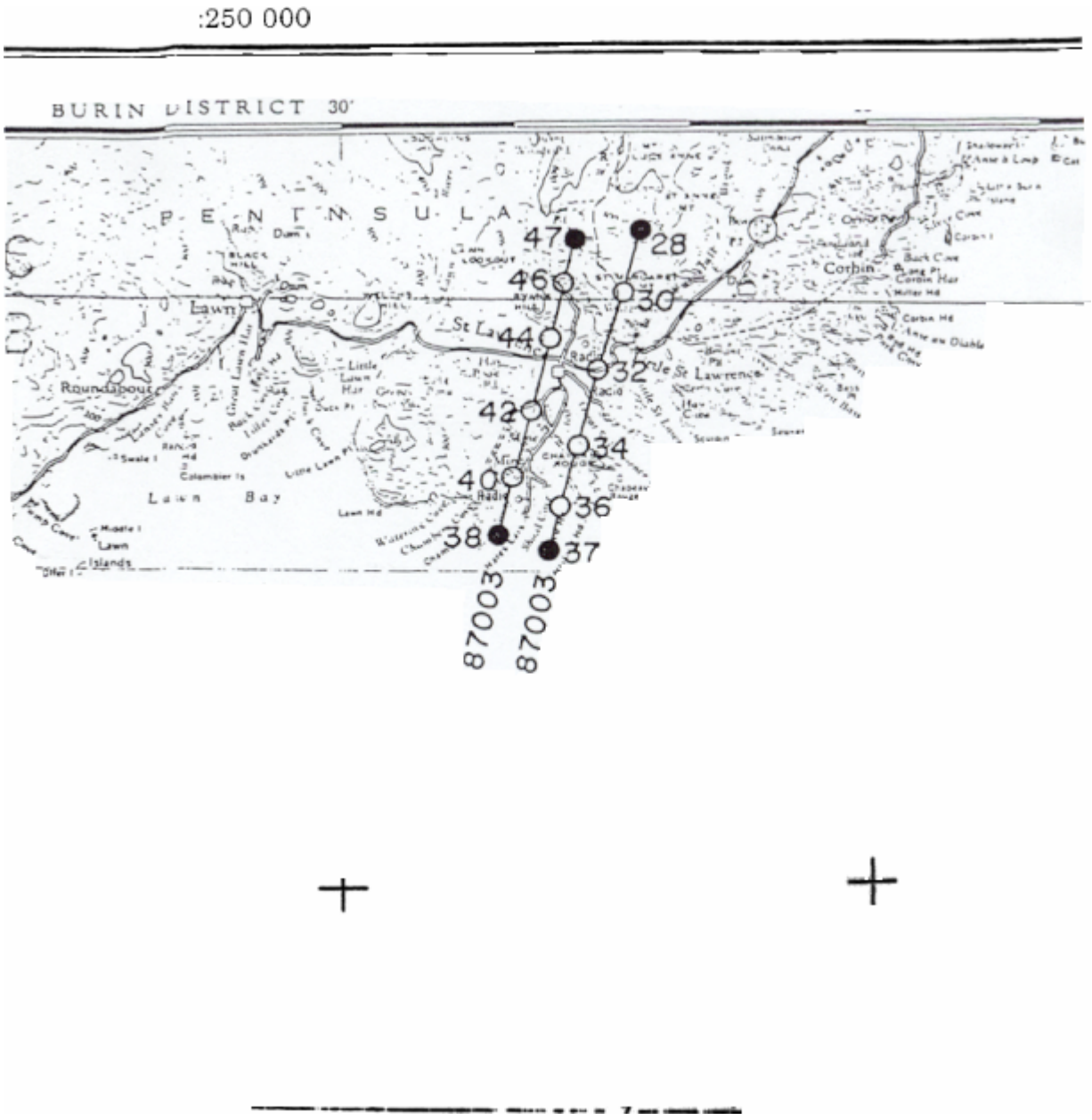

IL14-343
IL14-344
IL14-348
IL14-333
IL14-334
IL14-335
IL14-323
IL14-324
PENINSULA
BURNT WOODS HILL
ST ANNE MOUNT
ST MARGARET MOUNT
LAWN LOOKOUT
BLOW ME DOWN HILLS
CALIPOUSE
CHAPEAU ROUGE
PINNACLE
Cape Rosey
Middle Head
Kansas Point
Red Head
Ferryland Head
Hares Ears
XC
XB
05
04
03
02
00
99
98
95
94
93
92

Figure 14

Index map at 1:250,000 of the two May 27, 1987 flight lines over St. Lawrence showing the photo centres of each negative. Photo negative numbers 33 and 34 cover the St. Lawrence Harbour and these would have been the photos from which the contractor drew "mean sealevel".


:250 000
BURIN DISTRICT 30'
PENINSULA
Lawn
Roundabout
Lawn Bay
Islands
Corbin
St La
de St Lawrence
47
28
46
30
44
32
42
34
40
36
38
37
87003
87003

One other set of maps exist for St. Lawrence. The town and the Newfoundland and Labrador Department of Municipal Affairs commissioned a town plan in 1984 to guide further development. W. B. Titford Limited of St. John's prepared the document, apparently based on September 1973 aerial photos. These maps are at 1:4,800, as reduced from the 1:2,400 parent maps, and are contoured at a five foot interval (Titford Limited, 1984, revised 1991). The current Municipal Plan was first approved in 1985 and it was revised and approved in 1991 (Town of St. Lawrence, 1985 and circa 1991). The Municipal Plan nowhere mentions, or allows for, any shoreline hazard from a possible tsunami despite St. Lawrence's experience in 1929. For example, there is no shoreline zoning that restricts development to a non-residential type of use in low areas susceptible to a possible tsunami's runup.

DATA AVAILABLE FROM PRINTED OR ARCHIVAL SOURCES

No information on the Monday, November 18, 1929 'South Coast' Disaster got out until the S.S. PORTIA sent its message from Burin on the morning of Thursday November 21st, two-and-a-half days after the tsunami struck. The first message to get out directly from St. Lawrence was sent by Mr. Aubrey Farrell, dated Saturday, November 23, 1929. His message was brief[11]:

> **Following the shock on Monday evening an unpre-cedented high tide presumably tidal wave practically de-molished all the waterfront here including fishing plants, stores, traps, fishing gear, boats, engines etc. Two families were left homeless but no lives were lost although many narrowly escaped being drowned. Two dwelling[sic] were carried countrywards about four hundred feet from their foundations. The loss is difficult to estimate but it must be over two hundred thousand dollars.**
>
> **FARRELL.**

Mr. Adolph A. Giovannini, a son of an Italian immigrant and one of two brothers who emigrated to Newfoundland, ran a fish business in St. Lawrence. He travelled by the coastal ferry, S.S. GLENCOE, to Argentia early on the morning of Sunday, November 24, 1929 and connected with the train to St. John's. He was interviewed by *The Evening Telegram* at The Hotel Newfoundland on the afternoon of his arrival in the city. The article printed in the Monday, November 25th newspaper (p. 6, cols. 4-8) gave some additional details about the experience in St. Lawrence:

> **After Mr. Giovannini had partaken of tea with his wife, they left their house about 7.30 to proceed to their own store which was only a few yards away. While they were crossing the wharf Mrs. Giovannini's attention was attracted by the unusual swiftness of the tide, which caused the shores underneath the pier to making cracking sounds.**
>
> **Men Warned in Time**

She told her husband that something unusual was likely to happen and implored him to give warning to the fifteen men who were working at fish in the store. Mr. Giovannini notified the men promptly, and just as they had made their exit from the premises, the first tidal wave rushed in over the pier, and, in receding, a skiff which was moored at the pier was swept away and smashed to pieces. The tides increased as they appeared, and the third one which was about twelve feet high wrecked the Government bridge, and a large portion of the timber dashed against the shores underneath Mr. Giovannini's store and shook it almost from its foundation.

Store Washed Back

Scarcely without a word of warning to the eye-witnesses standing about a huge wave swept over the mainland, and the receding sea swept away the store with all its contents, but to the great surprise of those standing about, it was washed back again and grounded near its original site. The store which was of wooden structure measuring 65 feet by 30 feet, and containing three storeys, was later found broken in two, while all of the supplies which were carried on the first and second flats had been carried away. Mr. Giovannini's loss is estimated at $30,000. His house which was situated only a short distance from the store was in danger of being swept away on two other occasions. Mr. Giovannini says only seconds elapsed from the time he gave warning to the men in the store, until the building disappeared, and in this connection the saving of life was largely due to his wife.

Fishing Premises Swept Away

Mr. Giovannini went on to relate that great destruction was caused to fishing premises in St. Lawrence. Not one flake or stage was left standing following the tidal wave. All the boats with engines installed were carried away and smashed to pieces, and the loss in this connection is very great on the fishermen. In addition to Mr. Giovannini's business premises being swept away, the Co-Operative Stores with its wharves and flakes was considerably damaged, as well as T. Farrell and Sons premises.

Nine Families Homeless

At the bottom of the harbour nine houses were destroyed. All the families barely escaped with their lives, and are at present homeless. Mr. Giovannini was particularly gratified to be able to say that there has been no loss of life in St. Lawrence, but at the same time the people were horror stricken and were unable to sleep for nights following the disaster. Of the nine houses, six were swept to sea, while two were washed back with the tide and landed several hundred feet in on the mainland. Among those who lost their homes were Pike (3); Hendrigan, Malloy, and Fitzpatrick. The home of the latter was one of those which was carried to sea and completely lost sight of. Another building which also went was the Postal Telegraph office.

Operator Remained to the Last

Miss Fewer, the operator, remained at her post regardless of the danger and tapped on the keyboard a warning to people at Burin. Her escape was miraculous. The main road which is only a short distance from the waterfront was badly damaged by the tidal wave, while other bridges besides the Government bridge were swept away.

Wave 30 to 40 Feet High

Mr. Giovannini says it was a clear moonlight night when the disaster occurred. The tidal waves could be seen very clearly, and on receding out the harbour to meet an oncoming one, the water would rise thirty to forty feet in height, and with the roar of the water and the cracking of timber, the spectacle was terrifying.

[p. 6]

In the Tuesday, November 26th *Evening Telegram* an article bylined 'T. Echcgary'[sic] = Theo. Etchegary was published as a firsthand, though perhaps a somewhat exaggerated, account:

... and when about two hours later a terrific roaring of the sea was heard, fear struck the hearts of all. A few minutes after, a tremendous wall of water burst into the harbor and swept with irresistible force upon the land, tearing down everything in its way as it rushed along.

WAVE AFTER WAVE

The din of roaring waters, of shouting people and the breaking up of buildings was terrifying. Many houses were carried bodily inland for a considerable distance and some of them deposited when the force of the huge wave was spent, whilst many others were broken into splinters. Then, with a mighty roar, the waters receded, carrying with them boats, fishing stages, stores and dwellings. Again and again the dreadful waves rushed in upon the land, each one more destructive than the last.

THE SIGHT AS DAWN CAME

At dawn next morning say beyond description was the sight that greeted the wretched people. All their fishing premises, stages, stores, boats, nets and other gear, as well as barns of hay and cattle swept away by the pitiless sea or strewn in fragments upon the shore. Houses, fishing gear, stores and wreckage of all kinds floating upon the still swollen and raging sea. In a blinding storm or wind, sleet and snow men and boys were trying at the risk of their lives to rescue some planks or sticks, the only remnants of their little property which represented their all, the result of their lifelong labor and thrift.

ALL BUT 2 STORES DESTROYED

All their fishing premises, large and small with the exception of two stores were destroyed, many of them filled with fish. All the boats and fishing gear were carried off or thrown in a shapeless mass of wreckage upon the shore. Added to this the provisions for the winter: flour, molasses, meat, etc., which were in their stores were also carried off. Several homes were destroyed and the people are reduced to a very pitiable condition. As the fishery this year was a poor one, only the barest necessities of life were procurable and now all is lost.

The estimated amount of damage and loss is from $150,000 to $250,000. [p. 5]

The St. John's *Daily News* printed virtually the same article the same day, without a byline crediting Etchegary but with a November 20th dateline and a few minor text differences.

Dr. H.M. Mosdell, the Member of the House of Assembly for the area, was on board the relief ship S.S. MEIGLE which visited St. Lawrence on the morning of Monday, November 25, 1929. He wrote a message to the Colonial Secretary, the Hon. A. Barnes in St. John's, from Burin later on the 25th; this message got out to St. John's by telegraph when the MEIGLE reached Argentia on Wednesday, November 27, 1929 and this was published later that day in *The Evening Telegram* (p. 6, cols. 5&6); *The Daily News* carried the same report the next day (p. 9, cols 1&2). Dr. Mosdell said in part:

AWFUL SITUATION AT ST. LAWRENCE

At St. Lawrence this morning we found the whole foreshore of the spacious Harbour strewn with the wreckage of the wharves houses and stores. The financial loss here due to destruction of property, of roads and of bridges must total at least one hundred and fifty thousand dollars. Two waves hit this place. The first did very little damage and was followed by a recession of the water which left the bed of the Harbour exposed inside a line across from the public wharf to the opposite side. Normally the water here is over thirty feet deep.

STORES FROM ONE SIDE OF HARBOUR TO OTHER

The extremely low tide was succeeded by the second tidal wave described as at least fifty feet high. It swept the Harbour with a circular motion throwing big stores from side to side of the port and leaving many of them hundreds of yards from their original sites. Giovannini's store originally on the South side of the Harbour was moved to the north side where it was smashed to matchwood the only part left intact being the firm's sign which rears itself starkly from the shattered store. In the height of the storm heavy buildings were tossed about like chips and it is a marvel that more lives were not lost from the flying debris. Fortunately few of the dwelling houses at St. Lawrence were destroyed and there is not so much destitution to cope with there, as at other places. [p. 6]

Under the headline "Telegraph Office is Anchored in Harbor!" *The Daily News* reported on Friday, November 22, 1929 (p. 3, cols. 7&8) that "Cox, [the telegraph] Operator [at Burin]" sent a 10 p.m. November 21st message from Burin "to George J. Veith, Esq." reporting:

St. Lawrence: — No lives lost, all flakes and store on both sides of the harbour swept away with all provisions and coal.

...

St. Lawrence telegraph office is anchored in middle of St. Lawrence Hr., and Lord's Cove telegraph office totally destroyed. [p. 3]

Operator Cox's same message was also found in *The Evening Telegram* on November 22nd (p. 6, cols. 4&5).

Rev. Father James Anthony Miller, the Catholic priest from Burin, was among a deputation of three that went from Burin on the S.S. DAISY on Friday, November 22, 1929 to Argentia and hence by train (Hon. George A. Bartlett and Captain W.H. Hollett) or, in the case of Father Miller, by car, to St. John's. Father Miller was interviewed by a reporter from *The Evening Telegram* on Friday evening just before the deputation met with the Newfoundland 'Executive Government'. The reporter's story the next day in *The Evening Telegram* (p. 6, cols. 4-6) cited Father Miller with a report about St. Lawrence and the telegraph operator Cecelia Fewer:

GIRL OPERATOR'S BRAVE
ATTEMPT TO WARN BURIN

> **"There was not time to give warning that the tidal wave was coming," says Fr. Miller. A few moments before the waters invaded the place Miss Fewer, the operator at St. Lawrence, had Burin on the wire, saying, "Oh my, everything is going here." Her office, it was later learned, was swept into St. Lawrence Harbor, but she was saved. [p. 6]**

The same article continued with various reports including one dated November 22, 1929 and sent from Burin by Captain F.S. Whelan of the coastal ferry S.S. ARGYLE. His report read in part:

TO THE RAILWAY MANAGER FROM
CAPT. S.S. ARGYLE

BURIN, Nov. 22

> **Called at Lamaline, Point au Gaul, Lord's Cove, Lawn and St. Lawrence today. Terrible destruction of property at these places also at Lance au Barque and Taylor's Bay.**
>
> **...**
>
> **Giovannini's stores containing 1,600 quintals of fish sunk in harbour at St. Lawrence. All waterfront property gone here. [p. 6]**

J.H. Dee, Inspector of Revenue Service, on board the S.S. DAISY as it was crossing Placentia Bay late on Thursday, November 21, 1929, prepared a report which was telegraphed to the Deputy Minister of Customs in St. John's early the next morning and appeared in *The Daily News* on Saturday, November 23rd (p. 3, cols. 3&4), and later the same day in *The Evening Telegram* (p. 6, cols. 7&8). Inspector Dee used almost the exact words of Operator Cox above:

> **St. Lawrence: — No lives lost, but all stages, flakes, stores and their contents of fish, fishing gear, provisions and coal, leaving nothing but dazed people and a scene of desolation. The loss is up in the hundreds of thousands of dollars and all the people are absolutely destitute. I have personally investigated conditions and am convinced that if relief is not forthcoming quickly, consequence will be serious. [Dee may be making a more general statement re the whole area struck by the tsunami in his final sentence, or in his final two sentences, even though they are**

listed under St. Lawrence in his dispatch as reported in the newspaper article.] **[p. 6]**

An update on the state of the St. Lawrence telegraph office was provided in *The Evening Telegram* of Monday, November 25, 1929 (p. 7, col. 6). It reported on Cul de Sac and St. Lawrence:

DWELLING HOUSE AND POST OFFICE
DESTROYED AT CUL DE SAC

FEMALE OFFICIALS SAVED TELEGRAPH INSTRUMENTS

Captain Wes Kean of the S.S Portia sent a wireless message last night to the management of the railway stating that no damage was done west of Lamaline as a result of the tidal wave, excepting the property of Stephen Spencer at Cul de Sac, which was washed away.

Since the above message was received the Hon. W.W. Halfyard, Minister of Posts, received a wire from Cul de Sac that the Post Office at that place was destroyed. A message was also received by the same department that the telegraph instruments in the post office at St. Lawrence, which was also swept from its foundation was recovered by Mrs. Fudge, the postmistress, and Miss Fewer, the operator, both of whom climbed a ladder and entered a window in the top flat of the building. The telegraph office at St. Lawrence is now functioning in new quarters. **[p. 7]**

Alex. Turpin also wrote an account of the tsunami's arrival in Little St. Lawrence, the harbour just to the east of St. Lawrence. It was published in *The Evening Telegram* of St. John's on Friday December 27, 1929 (p. 3, cols. 5-8):

EFFECTS OF TIDAL WAVE IN LITTLE ST. LAWRENCE

Channel Cut Through Beach Saved
Greater Destruction of Property

Editor Evening Telegram,

Dear Sir—So much has been said and written on the recent tidal wave and its consequences that any contribution of mine, I perceive, would at this time be superfluous. But as no one seemed to think it worth while to place us in the limelight when speaking of the losses sustained by the disaster, I will in justice to the place, and with your permission, mention a few incidents in connection therewith which would place us in the same category with those who suffered. Though our losses happily didn't embrace any sacrifice of human lives, there were a few at least who had a very close call, and the courage and foresight displayed by these on that occasion are only in keeping with the records of the victims of that dreadful tragedy. The so-called island (always a misnomer but now a reality) which juts out immediately in front of the inner harbor, was formerly the property of Newman & Company, but within the last hundred years has changed hands many times. It is now the property of Mr. Edward Turpin who resides there with his family. It is connected with the main land or cove by a high beach about one hundred yards long, and thirty yards wide, and serves as a shelter for the harbor which is one of the safest in the country.

Retreat of Mother and Children Cut Off

It so happened that on the night of the tidal wave, Mr. Turpin was absent from his home, being at Great St. Lawrence on business. Mrs. Turpin at the approach of the first tidal wave became alarmed at its unusual velocity, and seeing her stage and store go with the element thought discretion the better part of valour, and immediately gathered her children together, and wading knee-deep in the water made her way for the beach, the only exit from the island. On reaching the beach she discovered that her retreat was cut off by the highness of the tide, and being warned by the people on the main land not to attempt to cross, she waited until it had subsided. When calm was restored she with her children decided to cross the beach and had just barely reached the other side when a mountainous wave burst in cutting a large channel through the beach and practically sweeping the whole water front in the cove where five families were located.

Knelt in Prayer

The destruction of the beach at this time was a Providential happening for those in the cove, as it meant the release of the wave which would have swamped every home in the cove and probably cause much loss of life. The panic-stricken people had already vacated their homes after the first wave, and repaired to the higher levels where in the shelter of some rock they knelt in prayer like Pilgrims at a shrine, beseeching for mercy and making a hurried preparation for what they thought the inevitable, which happily did not come.

15-Ton Rock Lifted From Its Bed

To give some idea of the magnitude and force of the wave which wrought such terrible destruction in this vicinity and environs it may be interesting to state that a certain rock ten feet high and 6 feet both ways, weighing probably in the vicinity of fifteen tons, which lay off the cove, and served as a beacon for centuries, was lifted from its bed and deposited one hundred yards away.

Destruction of Life's Work

It is saddening to see so many nice homes acquired after many long years of persistent energy and thrift disfigured so, and as nearly all the proprietors are nearing the allotted span, they can never hope to be able to retrieve the losses inflicted. Other portions of the community suffered equally with us, one poor woman losing her house with all its contents. Therefore, when the question of rehabilitation becomes a reality as is being promised by a generous public, I trust we will receive due recognition, and that we shall share in the benefits with those who it is hoped are going to profit by the disaster. Our isolation which looked so serious at first is now partially relieved, thanks to the government for a temporary ferry.

Concrete Bridge Went Down Before Wave

Living in close proximity to the bridge which was a concrete structure, I had the opportunity to witness its collapse, and I venture to say that if it were built of iron it would have met a similar fate, as no structure could withstand the pressure of such a phenomenal tide. The destruction of this fine bridge has seriously impeded traffic between both harbors, and the people deplore the loss of this indispensable highway.

Thanking you for space, I remain,

Yours faithfully,

ALEX. TURPIN **[p. 3]**

The editor of the *Newfluor News* published a piece (Anonymous, 1970) entitled 'Tidal Waves' in the March issue of 1970. Its source was not clear but it appeared to have been drawn, at least in part, from an earlier 'Offbeat History' column of Michael Harrington in *The Evening Telegram* of St. John's. The mooted 'Offbeat History' column was finally located through the efforts of the staff at The Newfoundland Room in the Queen Elizabeth II Library at Memorial University of Newfoundland ([Harrington], 1970). The March 1970 Editor of *Newfluor News* (Anonymous, 1970) then proceeded to totally muddle up, what may well have been a circa 1924-25, atmospherically-induced, storm surge event, with elements of St. Lawrence's experience with the November 18, 1929 tsunami.[12]

The muddled account of 1970 then was picked up virtually verbatim, without a word of credit, by the students Edwards *et al.* [1973] who prepared their manuscript, *The History and Development of St. Lawrence* on a Summer 1973 Opportunities for Youth (OFY) Project

(Chapter 9, pp. 33-34). They then compounded the muddled account by getting the date of the 1929 tsunami incorrect; they used November 3rd, not 18th (Chapter 9, pp. 34-36)! Ena Farrell Edwards, who was an advisor to the OFY project, published a history of St. Lawrence in 1983 and in many respects she followed the format of the unpublished 1973 manuscript (Edwards with Buehler, 1984). She does not include the possible 1924-25 storm surge event and she has the date of the 1929 event correct. She recounts the escape of the Thomas A. Pike family:[13]

> **St. Lawrence has a long narrow strip of beach jutting out mid-harbour on which a road leads to its extremity, Shingle Point. The government wharf freight shed was situated on this point for years, before being moved to its present site. Also on this point was the home and small plot of land belonging to George Pike. He wasn't living there at the time of the tidal wave, having moved to the U.S.A., and the house was occupied by his son, Thomas A. Pike, a customs official and veteran of World War I.**
>
> **Shingle Point was in the direct path of the tides coming in. The Pike family had finished their evening meal and the three children were tucked in bed, and the parents were about to begin a game of cards with some friends who had dropped in, when they heard a loud roar. Going outside to see what it was, they heard loud cries from the townfolk on the main waterfront, telling them to leave the place immediately, run for their lives, the seas were coming in. In haste and fright they snatched the children from their beds and started to run to safety. The beach is approximately a quarter of a mile long, and they just made the end of it adjoining the town road, when the onslaught of the first wave covered it completely. The water went way above the second floor of the Pike house, but it withstood all three waves and remained standing when the water subsided.**
>
> **There was a small barn on the property in which the Pike's[sic] kept a horse name[d] "Jacko". The barn was taken out with the rush of the sea, and Jacko was in it. Men standing near but a safe distance from the waterfront noticed a dark object coming in on the next rush of water. Thinking it was a man they gave crys[sic] of encouragement and were ready with any assistance they could give. When the water reached its highest ebb, the object turned out to be, to their great joy, not a man, but the Pike horse, Jacko! The poor animal was so frightened he bolted past the road into the meadows and to the back woods. It was three days before he made his appearance back in town.**
>
> **When the Pikes went back to view their home the next day, they found everything in a watersoaked condition and ruined. The lamps were still burning and Mrs. Pike had bread baking in the oven at the time of their quick departure. This was now water-soaked dough. It was one of the wonders of that night, and talked about many, many times after, how that house had withstood that mad onslaught of water. The Pikes were glad it had and thanked God over and over for their miraculous and narrow escape.[14] [pp. 40-41]**

She also transcribes the words of Alfred Turpin describing his return to St. Lawrence from Saint-Pierre on the night of November 18, 1929 with his father Victor Turpin, his cousin Joe Turpin and a David Drake from St. Lawrence:

> **Finally, after what seemed an eternity we sighted what seemed to be a rock, we took it for the Eastern Shag Rock. Now we were looking for Lawn Island, but could not see it. Joe looked back and said "That's Lawn Island, not the Shag Rock." The latter was all under water as we**

passed by. Next a welcome sight loomed up, we could see our own headland, Chamber Point Head Rock. A full moon was just rising o're the ocean and the wind started to die out. Thankfully we hauled in for Cape Chapeau Rouge. Steaming in the harbour we went in the little house to have a warm drink. We were just off Herring Cove when we struck something. Looking around it seemed we were in a forest of wood. We ran upon a fish flake, all boughs were stood on their end. Finally, under the weight of the skiff, the flake split in two. We slowed the engine down, then we saw a red building floating towards us. I thought it was my sister's house, as it was painted the same color. Nearing it we found it to be a fishing store. We continued to edge our way in the harbour, through all the wreckage and debris, until we got to our stage head (wharf). The tide was high, extremely high, and we rolled everything in the stage. By that time the tide was going out, and going so fast we had to tie seventy fathom of rope on the skiff and let her go out with the tide, and when it came back the next time we hauled her right in around the fishing stage.

It was only then, and in talking with some men, that we realized the tremendous happening we had sailed through and were lucky enough to make our home port having ridden the crests of a tidal wave.

This was the last of Mr. Turpin's account, but he did add a little bit of humour. Having just made it from the French Islands and no doubt having a little something the law would love to come upon, he said,

"It was a great night to smuggle. There were no police officers or customs officials to trouble you. All you had to do was roll it ashore." [pp. 43-44]

Ena Farrell Edwards has written a second book, *Billy Spinney, The Umbrella Tree and Other Recollections of St. Lawrence*, and she briefly mentions the tsunami on page 8 but provides no further data on the damage done (Edwards, 1991).

The 1929 tsunami is briefly mentioned in Rennie Slaney's circa 1965 *History of Fluorspar Mining At St. Lawrence* which was finally published in 1975. Slaney's mention of the event (pp. 5-6) is not specific to the damage done in St. Lawrence, other than to note that no lives were lost in the community.[15] He repeats the widely-believed theory that: "The tidal wave apparently altered the course of the codfish and the bait because, for many years afterwards, the codfish and bait failed to come in our shores. As a result, our once independent and proud fishermen were forced to accept Government dole in the amount of $1.80 per month per person, or 6¢ per person per day." (p. 6). Preliminary research done by the author indicates the tsunami was not the cause of any failure of the fishery in the early 1930's (Ruffman *et al.*, in preparation b). Keith Stoodley in this work concluded that the failure of the fishery was in fact a failure of the bait fishery of squid, herring and caplin; squid and herring which are pelagic open ocean species would not have been affected by the passage of a tsunami. Capelin spawn on beaches and conceivably their life cycle may have been interrupted by a tsunami but the 1929 tsunami came in November, not in the spawning season which is much earlier in the Summer months.

In general, any popular historical writing on the community of St. Lawrence has not detailed the

effects of the 1929 tsunami, despite its major economic effect on the community. Rather, such writing has eulogized and commemorated the February 18, 1942 wrecks of the USS TRUXTON and POLLUX with the loss of 203 lives and the community's heroic role in saving 183 of the crew (Smith, 1942; Edwards *et al.*, [1973]; Brown, 1982; Edwards with Buehler, 1983; Strauss, 1988; Edwards, 1991). The debilitating scourge of the miners' disease is the other topic that has drawn the interest of writers (Edwards *et al.*, [1973]; Slaney, 1975; Leyton, 1975; Edwards with Buehler, 1983). In fact, there are considerable data readily available on the tsunami's effect in St. Lawrence had popular historians sought it out.

The Public Archives of Newfoundland and Labrador (PANL) afford a rich source of information on the damage done and on the subsequent relief work done in the various communities of the Burin Peninsula, including St. Lawrence. This source has not been widely used by historians and writers to date, though Staveley *et al.* (1986) of Memorial University of Newfoundland have done an initial indexing of the holdings in PANL Manuscript Group 636. I know of, and hold, only two unpublished senior student papers that have made use of some of the South Coast Disaster Committee's files (Andrews, 1994; Hillier, 1995).

The S.S. MEIGLE was mobilized virtually the moment the news of the disaster reached St. John's; it was on its way to the South Coast by the evening of Thursday, November 21, 1929. The MEIGLE administered relief from November 22nd to 27th, and in the report on the *Voyage of Relief Ship Meigle*, found at PANL, the authors (Lake *et al.*, 1929) noted on November 26, 1929 that:[16]

> **.. we found [at St. Lawrence] that the tidal wave had caused the greatest amount of property destruction seen at any of the places visited. Fortunately no loss of life occurred here, and very few cases of destitution had to be provided for.**
>
> **[p. 8]**

The voyage of the MEIGLE was followed up by the South Coast Disaster Committee with a detailed documentation of the losses by each family (South Coast Disaster Committee, 1931). Every head of a family making a claim was assisted by a Committee member, or its delegate, to fill out a copy of the six-page form *Statutory Declarations To be made by Claimants for Loss in the Earthquake Disaster, South West Coast, 1929*. In St. Lawrence, 117 such forms were completed and sworn; these are found at PANL in Manuscript Group 636, Box 21, File 3, St. Lawrence. The South Coast Disaster Committee staff then compiled the claims in preparation for awarding of compensation or partial compensation.

The compilation, 'Losses at St. Lawrence', then listed the 117 claimants by claimant number and name on some thirty-six 8½x14-inch sheets.[17] These sheets provide the most detailed record possible of the St. Lawrence tsunami losses. Everything possible is listed in the minutest of detail; fishing gear, puncheons, barrels, salt, rope, stages, flakes, stores, wharves, vessels, oars, sails, engines, fuel, oil, gasoline, coal, compasses, crops such as hay, potatoes and cabbage, longers, sticks, shores, beams, rails, pickets, lumber, fencing, tools, houses, furniture, stoves, clothing, fox and muskrat skins, land washed away, cash and quintals of fish. The details of each

family's losses give a wonderful cross-section of almost every family of the town. The losses of T. Farrell & Sons and A.A. Giovannini (both on the west side of the harbour) occasioned separate listings being the largest losses of all the claimants in St. Lawrence. The total losses claimed in St. Lawrence amounted to $81,892.61 (in 1929 Newfoundland dollars).

Codfish losses got special attention in a separate listing "Losses of Codfish Tidal Wave Disaster. Nov. 10th[sic], 1929.". This separate compilation shows how important salted 'fish' were to the St. Lawrence economy in 1929.[18] Only four pages of the list were found at the Archives, but the compilation for St. Lawrence seems to be almost complete. The compilation, as found, does not include the communities to the west of St. Lawrence. This compilation at $9.00/quintal shows the size and importance of St. Lawrence along the coast in 1929 and the effects of the tsunami on St. Lawrence and on its short-term economic well-being. Table 2 included here in the main report further compiles the community lists of codfish losses from east to west, ending with St. Lawrence — the remainder of the coast to the west is missing in the files at the Provincial Archives of Newfoundland and Labrador in St. John's. Even so, the losses of codfish in St. Lawrence are four to eight (or more) times larger than the losses in any other community listed, and the $12,700 total is equal to all the other losses in the other 22 communities to the east combined.

TABLE 2

Community losses of codfish in the 1929 tsunami, for twenty-three Burin Peninsula communities from St. Lawrence east to Rock Harbour

Community	Value of Codfish Lost
Boat Harbour	$ 108.00
Rock Harbour	335.50
Fox Cove	32.50
Mortier	234.00
Port au Bras	3,376.00
Bulls Cove	1,508.00
Path End	478.00
Burin North	1,640.00
Ship Cove	32.00
Collins Cove	9.00
Kirby's Cove	40.50
Mosquito Cove	70.00
Pardy's Island (Foote's Cove)	519.00
Kelly's Cove	693.00
Stepaside	662.75
Great Burin	256.50
Shalloway	135.00
Whale Cove	60.00
Black Duck Cove	54.00
Sandy Point	44.50
Burin Bay Arm	128.25
Corbin	146.00
St. Lawrence[19]	12,680.00
Subtotal[20]	$23,242.50

I earlier quoted from a portion of Stephen Cusick's unpublished manuscript 'Fight For Survival' (circa 1994); the manuscript is held by his son John Cusick of Herring Cove, St. Lawrence, and he and his wife Emma, who is rewriting it with some editing, have kindly shared a copy of this unique document with me.

Mr. Cusick included the 1929 'tidal wave' in his narration and this provides a graphic witness to the event as well as giving us data on the elevation of the tsunami's height.

Now where we lived was real close to the water. When it would come a high tide it used to come right in around our house. I remember just before the tidal wave the water started coming up in our house because one morning I remember we were having breakfast [when] the water came in and my father [Joe Cusick] was sitting down to the table and the water was up half his boots and I was up 2 steps in the stairs watching him. Anyway it came up so often we moved upstairs to live and used the lower part to store firewood.

Then on the 18th November 1929 we had a tidal wave and took it all. As I remember me and some other boys were swinging on flake beam. We used to swing out over water and back again. When everything started to rock back a[nd] forth. So I beat it for home. That was about 5 o'clock in the evening. Well we didn't think anymore of it. [pp. 3-4]

But 7 o'clock someone came in and said "it's a big tide running in the harbour" so me and [my] sister came out and stayed out. My sister went back in and got a rag doll she had in her room. By that time my father was there as we had some flour in the house, that's barrels of flour. So he and some more men got them out and rolled them up about 200 feet up a lane [Slaneyvale]. Well that was the first tide. [During] the next tide the harbour dried out further and it came in further. So it was getting scary. So the next time [the] harbour dried right out and [the sea] rose up and came in and took everything with it including our house. But the cracking a[nd] grinding, roaring like thunder; it was terrifying. It was lucky nobody got drown[ed] in St. Lawrence. But some people got in the water trying to save the boats and things that the tide was taking away. It was around ten o['cloc]k that night everything was still. Beautiful moonlight night! Just a few snowflakes come down on all the wreckage that was left.

Well that's when real hard times started. We had nothing, only [the] flour [which] we [had] saved from the tide. We moved in with some other people for that winter and my father look[ed] for help from the disaster fun[d] to build another house but he never got half enough to finish it. I can remember laying on the floor and counting the nails in the roof with the frost on them, with a quilt and dory sail over me. As you see there was no loft in the house upstairs so you could look up in the roof.

Well that was the dirty thirtys then and after the tidal wave there wasn't a fish alive on the South Coast. We were on government help as everyone was then, except a very few people who had land and cattle. Well it was call[ed] the dole. But you had to work for it. Community work or work for someone who couldn't work, such as get[ting] firewood for them or something. Well there was four of us in [our] family so we used to get 20 lbs. of flour, ¼ pound of tea and one pint of molasses for a week.

Well we had no yeast to rise the flour most of the time, so we would mix up what we call[ed] lunch cakes. Baking soda and flour and it wouldn't rise; just make a hard lunch cake. And owing to that we would be three and four days without bread sometimes before we would get our next order for dole. So when we would be in the woods getting firewood I would eat blueberry leaves and these ferns and evergreens. The roots of the ferns was just like cheese and shellfish. We used to eat a lot of these. [pp. 4-6]

A whole album of about 244 historic photographs of St. Lawrence has fortuitously been preserved and is found at the St. Lawrence town hall (Wallace, 1937-1941).[21] While not taken in 1929, these photos show St. Lawrence nearly as it was at the time of the 1929 tsunami. Several

of these photos were duplicated by Mrs. Cynthia Farrell of Farrell Foto in St. Lawrence and several panoramas have been constructed to show the typical harbour flakes and fish stores and the general view of the eastern shoreline of St. Lawrence Harbour and Shingle Point where the Government Wharf was located. A probable 1933-34 view of the Pike house which survived the tsunami on Shingle Point can be compared to the 1938 view of the Point. John and Emma Cusick supplied a 1929 view of the west side of St. Lawrence Harbour which can be compared to Wallace's view of the west side in 1937 and to the aerial view of circa 1985 (Anonymous, *circa* 1985).

FIELD PROGRAM AND ORAL HISTORY INTERVIEWS

The field program began on Thursday February 21, 1995 with a snowstorm that caused an 11.5-hour travel delay in Halifax and continued from February 22nd to March 2nd in Newfoundland over five more snow and freezing rain storms. Alan Ruffman was able to operate quite satisfactorily out of the St. Lawrence Salt Cove Brook B&B of Cathy and Ron Way once he reached the field area. Travel within the confines of the community was generally quite manageable during the near continuous succession of storms. However travel across the barrens to communities such as Lawn and Marystown was quite difficult, or worse, during such storms.

Two oral history interviews with longtime St. Lawrence residents were available from Alan Ruffman's visit in November 1994. These were the interviews with Charlotte Turpin and Pauline Loder (Table 3). During the February 1995 field visit, a further seven taped interviews were conducted (Table 3). Verbatim transcripts of all nine interviews were made on return from the field.[22] While the transcripts are intended to be exact, it is apparent that in a number of places the author's ear, and that of Wendy Findley the chief transcriber, have not always understood and captured the speaker.

It is the intention of the author to eventually deposit the raw interview tapes and a copy of the transcripts with the Memorial University of Newfoundland Folklore Archives (MUNFLA). It may well be that MUNFLA can improve slightly on the transcripts. All interviewees gave their verbal permission for the deposit of the interviews in an appropriate archive so others could listen to them in the future.

Three further interviews were held with informants where no tape was used, but notes were kept or written directly after the interview/meeting. These three included Kevin Pike, son of Thomas (Tom) Pike whose house was flooded by the tsunami out on Shingle Point; Kevin Pike was cited as a person with an interest in the history of the community. Also included was Mrs. Ena Farrell Edwards who wrote and published the first community history in 1983. I also revisited Charlotte Turpin who I had interviewed and taped on November 19, 1994. The input from Kevin Pike and Ena Farrell Edwards was further supplemented by their letters of April 25 and April 17, 1995 respectively, with more information relevant to the height of the tsunami as it crossed Shingle

Point and inundated the Thomas (Tom) Pike house.[23]

Thus the oral history component of this study consists of nine taped interviews, five of which were mainly with women (Table 3). Two other interviewees contributed useful material, one man and one woman (Table 3). Numerous other contacts contributed quite valuable material such as John and Emma Cusick who have an interest in both the local town history and in their own family history. They were able to supply a most interesting narrative of John's father (Cusick, circa 1994). Ms. Meta Turpin, the librarian in the Town Hall, directed the author to some relevant published information that he was unaware of.

TABLE 3

Log of interview tapes and interviewees

Cassette Tape No	Date of Interview	Interviewee	Comments
94-7, Side 1	Nov. 19, 1994	Charlotte Turpin (Mrs. Alfred), née Perks	Length 10.75 minutes.
94-7, Side 1	Nov. 19, 1994	Pauline Mary Loder (née Shea)	Length 17 minutes.
94-7, Side 2	Nov. 19, 1994	Pauline Mary Loder	Two songs.
95-1, Side 1	Feb. 25, 1995	Michael Joseph Turpin	Length 34.5 minutes First bit got erased accidentally during transcription. Also put a tidal wave folksong on the tape in error in the middle of the interview.
95-1, Side 2	Feb. 25, 1995	Archibald Joseph Slaney	Length 25.5 minutes
95-1, Side 2	Feb. 25, 1995	Vince or Joe Baker	Folksong about 'tidal wave'; not transcribed here. Length 3 minutes.
95-2, Side 1	Feb. 26, 1995	Gertrude Frances and Norbert Lionel T urpin, but mainly Gertrude Turpin (née Kelly)	Length 34.5 minutes.
95-2, Side 2	Feb. 27, 1995	Emma Blanche Boxy) Pike (née Blagdon) and her son Levi Pike	Length 25.5 minutes
95-2, Side 2	Feb. 27, 1995	Elizabeth Madeline Slaney	Length 11 minutes.

TABLE 3
(continued)

Cassette Tape No	Date of Interview	Interviewee	Comments
95-3, Side 1	Feb. 27, 1995	John M. Kelly N ellie Kelly	Length 42.5 minutes
no tape	Feb. 27, 1995	Kevin Pike	notes only, April 25, 1995 letter (Appendix 6 in the separate Volume 2 - Appendices and Enclosures)
no tape	Feb. 28, 1995	Charlotte Turpin	notes only
no tape	Feb. 28, 1995	Ena Farrell E dwards	notes only, April 17, 1995 letter (Appendix 6 in the separate Volume 2)

CONSTRUCTION OF THE MAP OF THE 1929 TSUNAMI RUNUP ZONE

Ideally a tsunami runup map is made within a few days or weeks of an event and can be mapped directly on the ground from the swash line, flattened vegetation, lines of debris and the location of wreckage. Such information is then surveyed *in situ* or visually transferred to aerial photographs or onto detailed topographic or cultural maps.

In attempting to do this just over 65 years after the November 18, 1929 event, one must contend with the fact that all such physical evidence is gone, especially in an urbanized area such as St. Lawrence. Within hours, and certainly beginning by the morning of Tuesday, November 19, 1929, roads were being cleared of debris, useful fishing gear, lumber, logs ('sticks') and building parts were being salvaged for reuse, boats and skiffs were being returned to the water, and intact buildings that had floated were being skidded back to their proper places or they were being 'taken down' for their salvage value. Thus the Fitzpatrick, Molloy and Handrigan houses which had moved, in some cases a considerable distance inland in the 'Riverhead' area, were all relocated and are in use today (though the Handrigan house was in the early stages of being taken down during my field visit in February 1995).

The pulsing of a tsunami wave is seldom a simple process in the nearshore area. In the case of

Great St. Lawrence Harbour (Figure 10), any one pulse of the wave would have already been complicated by the somewhat variable topography of the ocean floor at the harbour entrance. There is shoal water at Point Rock and to the west, as well as to the southwest of Keenan Point etc. (Figure 11). The motion of each tsunami wave would have been further complicated by the major constriction of the harbour from Blue Beach Cove to Blue Beach Point and, to a lesser degree, at Herring Cove (Figure 11). These shoreline protuberances or coves would have led to complicated reflections and very minor refractions as the wave moved inwards at about 40 km/hr in its final stages. The main two (or three) waves were breaking waves inside of Blue Beach Point according to all witnesses.

The final complicating morphology, or harbour shape, was the long gravel and sand 'point of beach' known as Shingle Point (Figures 11 and 12). Shingle Point, even in 1929, had been subject to significant anthropogenic alterations to put a major government pier across the northeast end. We also know that the nearby Thomas Pike house was bolted down to a 'breast works', or stone-filled crib, buried in the body of the Point along its axis (foldout Map 1).[24]

Initially Shingle Point impeded and reflected the tsunami wave until water levels rose enough to allow the tsunami wave to flow over Shingle Point and to pour inwards — like a huge river reversing direction. The last topographical barrier to the tsunami was 'the strand', a low sandy, crescentic, baymouth bar that closed off a small tidal pond at the very head or 'bottom' of the harbour where Riverhead Brook emptied (Map 1).

Thus in the inner portion of Great St. Lawrence Harbour (Figure 12) the initial motion of the first returning tsunami pulse was quite complicated as it swirled past the constriction of Shingle Point and over 'the strand'. Each of the tsunami's pulses came in after a major withdrawal of up to 3.7 m below the Canadian Hydrographic Service chart datum. According to Stephen Cusick (circa 1994; p. 77) the third withdrawal completely dried out the harbour off the government wharf at the end of Shingle Point (Figure 12). Once each of the main pulses came in and rose high enough to flood over Shingle Point, the tsunami motion was probably less complicated for the remainder of the pulse. At the 'Riverhead' the momentum of the tsunami wave carried it well up over the 'Riverhead Road', over the 'government bridge' that crossed the brook (Map 1), and into the low peaty meadows 'inside' to the north northwest (Figures 10 and 11).

One disadvantage of using the recollections of the older residents as transcribed from the oral history interviews is that the memories of the relatively few remaining first-hand witnesses may well be fading and their recollections can be, and at times are, coloured and enhanced by the repeated telling of various stories of other community members about the 'tidal wave'. The second disadvantage of using oral history material from St. Lawrence residents is that most interviewees were often not familiar with the use of maps.

All my interviews were done with more elderly persons who were generally not able to go outside with me in the severe winter conditions and to drive along the harbour's edge to point out

locations and places that they mentioned in their interview. Thus, initially I was not absolutely clear where 'The Dock' area was located to place Pauline Slaney's (now Loder) family's home on the west side of the harbour in 1929. Often an interviewee was absolutely certain and clear in locating a feature verbally but was quite unable to place it on the copy of the basemap which accompanied me at all times (a folded copy of the full sheet of Map 1 that covered mainly the harbour and all the potential runup zone).

All that being said, there is in fact a good database of knowledge about the effects of the 1929 tsunami among the older residents of St. Lawrence. It was possible to sort through most conflicting recollections and, in some cases, it was possible to pick the recollection in which one placed the most confidence and to further sort out some of the inconsistencies.

The other factor that assists one in plotting the runup limit is that we know that on the evening of Monday, November 18, 1929 the sea was dead calm. Thus if one is able to determine the tsunami's elevation at one point, that elevation will translate for some distance along the harbour's edges and should translate across the harbour.

Water Street West today, in the area of the intersection with Causeway Road, is about 2.2 m higher than Water Street East on the opposite side of the harbour. It would appear that this was true as well in 1929 from the location of the homes and their yards known to predate the tsunami. Thus all of Water Street East 'inside', or northwest of, the Michael Turpin home (Map 1) was flooded by the tsunami and Mr. Turpin indicated that the water came halfway up the yard from the road in 1929. This would appear to be about to the four-metre contour on the basemap seen in Map 1. This elevation was confirmed in an interview with Archibald Slaney with respect to the tsunami elevation in front of Ambrose Fitzpatrick's house on Church Lane opposite Causeway Road, and from the report that the water came to the very front of one of St. Lawrence's oldest houses, that of 'Uncle' Walter Pike (Map 1). It is again approximately confirmed in knowing the initial location of the John Handrigan house which floated off and moved some distance (Map 1). The four-metre contour on Map 1 would appear to be the tsunami's maximum height.

As the tsunami moved inwards and was further constricted along its edges and by a shallowing harbour floor, the tsunami height would have risen. A look at the elevation contours on Map 1[25] shows that this would have begun to occur 'inside' (northwest) of the present Causeway Road area. We have considerable evidence on the runup height off the northwest end of the harbour in a number of locations.

On the west side of the harbour, Water Street West is higher than four metres above sealevel all along its length (Map 1) until one gets up to the northwest end of the harbour near the present day Causeway Road (which was not there in 1929). Mrs. Gertrude Turpin (née Kelly) and her brother John indicated that the tsunami came up to the front of their home on Water Street West which suggests a tsunami height of five metres on the contours of Map 1. The only firm evidence we have of the water crossing Water Street West is to the northwest of the present

Causeway Road where there is a report of barrels of flour floating in the lower portions of Slaneyvale — a small lane that passes up the hill (Map 1).

The Joseph Cusick house was located on the water side of Water Street West essentially over the 'landwash', or intertidal zone, in what is now the location of the small 'FoodStop' G & E Convenience store (Map 1); the Cusick home was located 'outside' (southeast) of 'the strand' baymouth beach (Map 1). The Cusick house was lifted and moved up into the meadows (Map 1) where it grounded with considerable damage to its lower storey. The Cusick home illustrates a problem which was encountered with all the buildings that moved. While the initial location of the building that moved can be fairly well established, its final location after the tsunami is often much less certain. In the case of the Cusick house, its final grounded location may yet be established with the help of Mr. Steven Cusick, who was exactly ten years, nine months old on the date of the tsunami and who is still alive today. Mr. Steven Cusick was unable to go into the field in February 1995.

Adolph A. Giovannini's account, published in the November 25, 1929 *Evening Telegram* (p. 65, this report), apparently stated that:

> **At the bottom of the harbour nine houses were destroyed. ... Of the nine houses, six were swept to sea, while two were washed back with the tide and landed several hundred feet in on the mainland. Among those who lost their homes were Pike (3), Hendrigan[sic], Malloy, and Fitzpatrick. The home of the latter was one of those which was carried to sea and completely lost sight of. Another building which also went was the Postal Telegraph office. [p. 6]**

Elsewhere in the *Daily News* of November 25, 1929 (p. 6, col. 4) the total is given as "Eight dwellings were shifted and one totally destroyed." Presumably the one house destroyed was the Fitzpatrick house cited by Giovannini above.

However the first message to get out from St. Lawrence was sent by Aubrey Farrell (p. 64, this report) and he stated, "Two families were left homeless ... Two dwelling[sic] were carried countrywards about four hundred feet from their foundations" (*The Evening Telegram*, Monday, November 25, 1929, p. 6, cols. 4&5). Even Theo. Etchegary's exaggerated account published on November 26th only referred to "Several homes were destroyed ..." (p. 66, this report) but he did say, "Many houses were carried bodily inland for a considerable distance ...". Mr. Etchegary probably should have said, "Many buildings ..." and not implied that they all were dwelling houses. Dr. H.M. Mosdell of the S.S. MEIGLE, which visited St. Lawrence on Monday, November 25, 1929, wrote only that, "Fortunately few of the dwelling houses at St. Lawrence were destroyed and there is not so much destitution to cope with there, as at other places." (p. 68, this report).

A.A. Giovannini would appear to have been mistaken in his estimate of nine 'houses' that were destroyed. In my oral histories and in the detailed lists of losses I have only found reports of

eight dwelling houses which moved; those of John Handrigan (Claimant #68), Joe Molloy, Joseph Cusick (#3), Angus Pike (#67), Michael Fitzpatrick (#23), John Beck (#71), Mrs. Ed. Lundrigan (#20) and Benedict J. Slaney (#109) which moved along with the postal-telegraph office operated by Mrs. Sylvia Fudge, postmistress, and Miss Cecelia Fewer, operator. Thus eight dwelling 'houses' that were located at the 'bottom' of the harbour directly in the path of the tsunami in the runup zone, or near 'the beach' at the southeast end of Water Street West, were floated off and moved along with the postal-telegraph office; only one of the nine buildings was a total loss. There was, however, an almost complete obliteration of all the fishing stages, wharves, stores, and flakes on the lower (harbour) side of Water Streets West and East.

The small two-storey John Handrigan house was located just to the north of the RCMP station in about the location of the present-day John Roach house. It was moved well up into the meadow though the exact location is in doubt (Map 1). Joe Molloy was absent in the United States in late 1929 and his vacant house was apparently located on the water side of Water Street East at about the east end of 'the strand' opposite the present Post Office. I have varying reports on its final location when it grounded as the tsunami withdrew. It was either somewhat close to the Handrigan house, or on the old football (soccer) field, which was just south of what is now Highway 220 (Map 1). These two reports may not be inconsistent. Another informant put the old football field in the area just south of the 'DREE (High) School' (Map 1). The present locations of the relocated houses are also known (Map 1). The Molloys apparently never made a claim for damage, or at least they are not represented on the detailed claim sheets.[26]

We do not know where the remnants of the Joseph Cusick house ended up on the meadow. As mentioned above, his son Stephen still is alive and perhaps he can still assist to locate the final resting spot.[27] Similarly, we do not know where the Fitzpatrick house moved to, though I am told that it is now relocated close to its original location near the foot of Notre Dame Street (Map 1). While the Angus Pike house near 'the beach' at the south end of Water Street West moved, "it didn't get out of the area" (Blanche Pike interview). As well, the anchored, or grounded, location of the large two-storey postal-telegraph office "in the Harbour" outside of 'the strand' is not known. The Slaney house only moved ten feet, while the Beck house is cited as "moved from foundation" and that of Mrs. Lundrigan is noted as "house completely destroyed" on the respective claim forms. We do not yet know the original locations of these latter three homes in 1929. The Thomas Pike house on Shingle Point did not move. We suspect the reports of the house being wetted to the top of the first storey may reflect, in part, water splashed up as the tsunami violently flowed up to and around the house, or it may reflect local runup, as the tsunami surged up and over Shingle Point.

In the tsunami runup zone off the northwest end of the harbour we also know that the tsunami entered the lower corner of the Mount Cecilia Catholic Cemetery and still had enough force to topple some headstones and crosses. Finally, all reports of the 'jackboat' that was lifted from its (unknown) anchorage point in the Inner Harbour and moved inland have it grounding close to, or north of, the present Highway 220. The 'Lawn Road', or Highway 220, was not present in 1929; instead, in 1929, the main road ran along Riverside Drive and/or the 'Riverhead Road' crossing over Riverhead Brook via the 'Government Bridge' and hence onto Water Street West. The

above 'jackboat' and cemetery data points for the 1929 tsunami runup show that the tsunami crossed somewhat north of the present Highway 220.

Map 1 in this report (and Enclosure 1 in Volume 2) show the results of the analysis of the tsunami height and tsunami runup height data, along with the best guesses of the grounding locations of the dwelling houses which moved. The tsunami runup limit suggests an apparent runup height of as much as 13 m as plotted on the contours of the 1988 Newfoundland and Labrador Department of Environment and Lands 1:2,500 map sheets used to construct our basemap[28] (Map 1). This runup height compares to a probable runup height of 10 m (relative to geodetic datum) estimated at Taylor's Bay by the author with Martitia Tuttle at the University of Maryland (Ruffman and Tuttle, 1995; Tuttle *et al.*, 1995).

Thus in St. Lawrence Harbour the tsunami height was about 4 m and the tsunami momentum carried it to an apparent runup height of about 13 m and to a distance of at least 760 m inland from the estimated position of the seaward side of 'the strand' in 1929. The area within the 1929 tsunami limit on Map 1 is referred to as the 1929 'tsunami runup zone'.

VERTICAL DATUM UNCERTAINTIES

While these are not large, they do pose a vexing problem that is not yet fully solved. There are two problems. In Figure 8, I present the hindcast astronomic tides for the secondary tidal port of North Sydney, Nova Scotia, related to the present Canadian Hydrographic Service (CHS) chart datum in Nova Scotia along with the CHS estimate of the 1929 chart datum. While I have been provided hindcast tidal predictions for the astronomic tide based on the secondary tidal port of Saint-Pierre, in the islands of Saint-Pierre et Miquelon, I have not yet been satisfactorily provided the relationship of these predictions to the chart datum used on the south coast of the Burin Peninsula and specifically to that used on CHS Chart 4642 (Figures 11 and 12). (Nor do we yet have CHS's estimate of the chart datum shift on the south coast of the Burin since 1929.)

As earlier noted (p. 58), the topographic contours on the 1988 Newfoundland and Labrador Department of Environment and Lands 1:2,500 map sheets used for Maps 1 and 2 are based on "mean sealevel" as determined by the contractor from photo 33 or 34 on Line 87003 at 1837+13.3 seconds GMT on May 27, 1987. CHS has not to date been able to provide us the hindcast astronomic tide at this flight time for St. Lawrence so that one cannot yet do a block shift of the topographic contours on Maps 1 and 2 from being relative to "mean sealevel" at 1837+13.3 seconds GMT (1507+13.3 s NST) on May 27, 1987 to being relative to the hindcast average level of the astronomic tide during the mid-point of the arrival period of the tsunami (circa 1945 NST, November 18, 1929). The same block shift would apply to any estimates of the tsunami height or tsunami runup height made from the contours on Map 1. The block shift is believed to be small relative to the tsunami runup height — probably less than 0.5 m — but it is presently not known. If the contours on our basemap were based on a 1987 dead low spring tide

"mean sealevel" and a future 1929-like tsunami were to arrive at a high spring tide, the actual runup height could be somewhat higher than the 13 m estimated above, i.e. the tsunami might flow a bit beyond the 13 m contour off the northwest end of the harbour along the axis of Riverhead Brook on Map 1.

CONSTRUCTION OF THE MAP OF 1995 MODERN-DAY BUILDINGS WITHIN THE 1929 TSUNAMI RUNUP ZONE

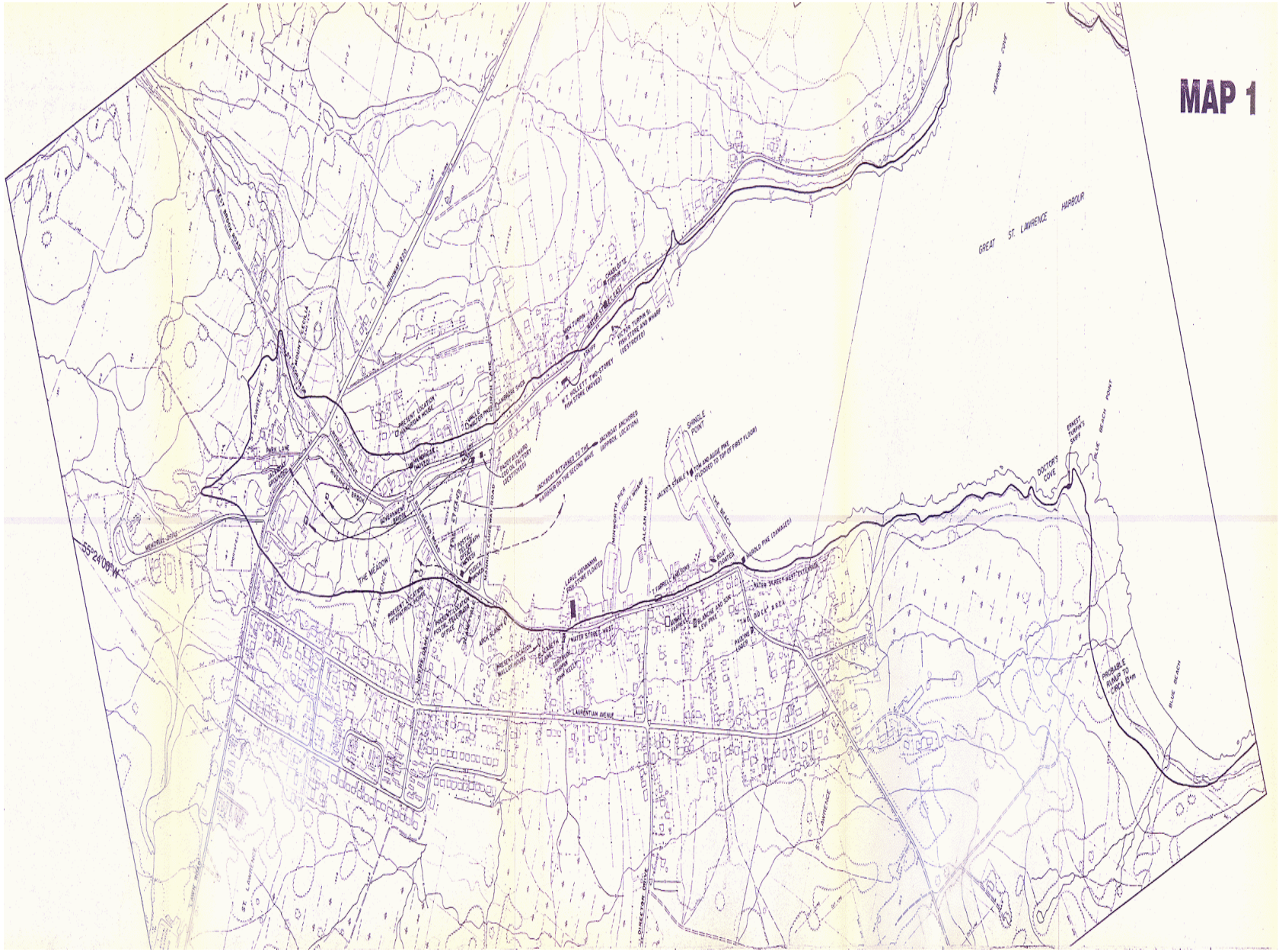
A second copy of the basemap was altered to add (or, in a couple of cases, to remove) buildings that have been built (or demolished) within, or close to, the 1929 tsunami runup zone since the maps were made in 1988. These alterations were obtained through a visual inspection of the area in the field and the new building positions were estimated relative to the structures already mapped on the 1988 basemap (Map 2). Table 4 at the end of the report text provides a list of existing businesses, agencies, homes and facilities that may be at risk if a 1929-like tsunami is repeated in St. Lawrence, Newfoundland in the near future.

Map 1

Area flooded by the 1929 tsunami, St. Lawrence, Newfoundland.[29] Map 1 is a linear slice out of the main Enclosure which has been reduced to 1:5,000 and designed to run along the harbour axis so as to include all the areas affected by the 1929 tsunami.

The solid line indicates the 1929 tsunami runup limit. The solid filled-in buildings (or the boat) show those which moved. The shaded hachures on buildings show the 1929 buildings of the 1994-95 interviewees. The open highlighted buildings are other buildings mentioned in the text.

Note: map is not to scale and has been skewed vertically to improve readability.


MAP 1
GREAT ST. LAWRENCE HARBOUR
55°24'00"W
THE MEADOW
LAURENTIAN AVENUE
DOCTOR'S COVE
BLUE BEACH POINT
BLUE BEACH
SINGLE POINT
THE BEACH
ALCAN WHARF
PROBABLE RUNUP TO CIRCA 8m

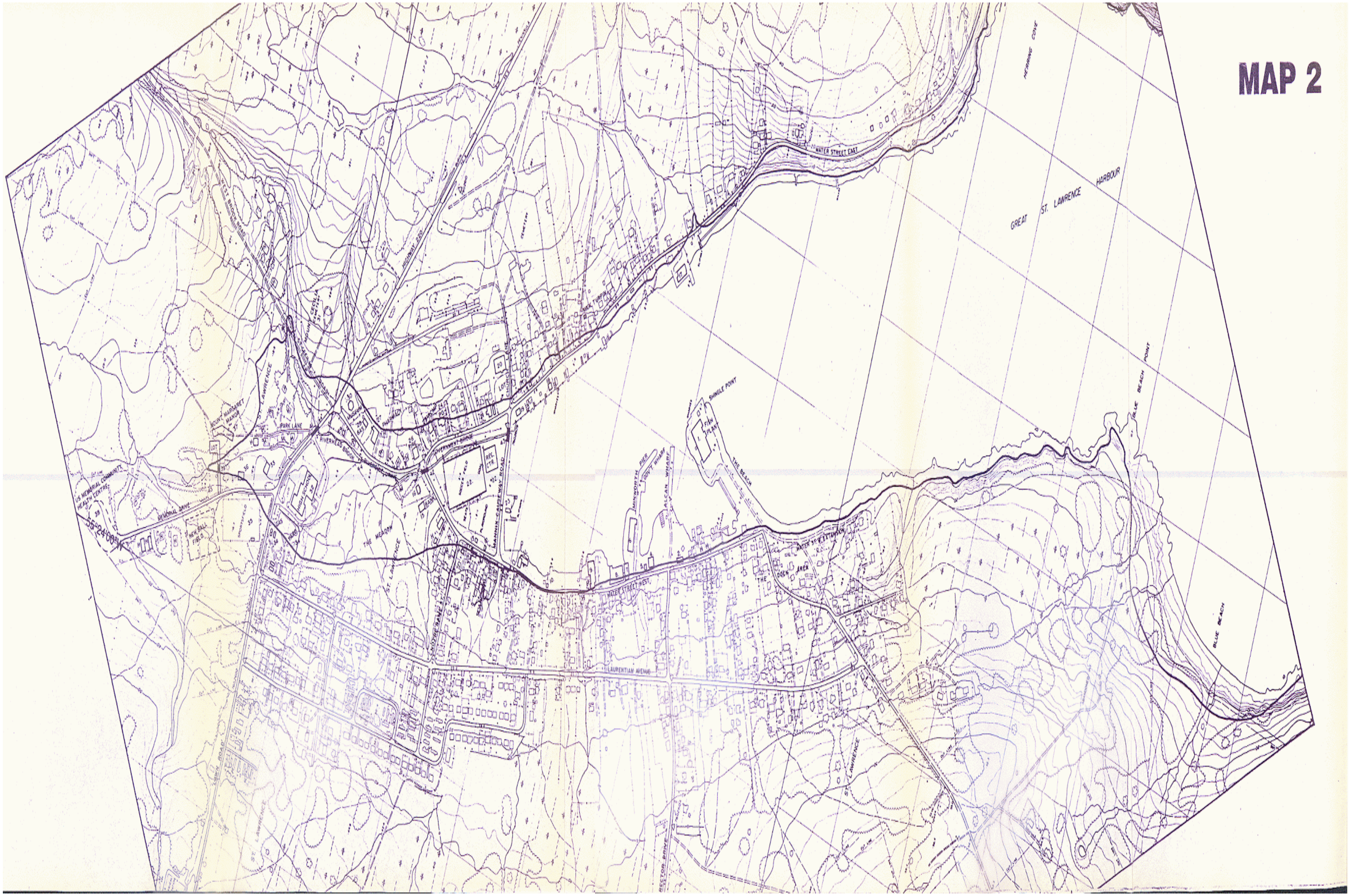
Map 2

Modern-day buildings and uses susceptible to a 1929-like tsunami, St. Lawrence, Newfoundland.[30] Map 2 is a linear slice out of the main Enclosure which has been reduced to 1:5,000 and designed to run along the harbour axis so as to include all the areas affected by the 1929 tsunami.

The solid line indicates the 1929 tsunami runup limit. The open highlighted buildings and facilities are possibly at risk; the numbers can be matched to Table 4. Open highlighted buildings marked 'H' are residential dwellings that may be at risk. Susceptible bridges or culverts are shown as solid filled-in symbols.

Note: map is not to scale and has been skewed vertically to improve readability

MAP 2


HERRING COVE
GREAT ST. LAWRENCE HARBOUR
WATER STREET EAST
SHINGLE POINT
BLUE BEACH POINT
BLUE BEACH
LAURENTIAN AVENUE
PARK LANE
THE MEADOW
U.S. MEMORIAL COMMUNITY HEALTH CENTRE

The existing uses within the 1929 tsunami runup zone were inventoried in the field and are plotted on Map 2 and are listed in Table 4. There are about thirty residential dwellings located within, or very close to, the 1929 tsunami runup zone, on the southern part of Water Street West, at the foot of Notre Dame Street, in the area of Riverside Drive and in the newly-built-up area just north of Highway 220 in the [trailer] Park Lane area. All of St. Lawrence's fishing industry is still vulnerable to a 1929-like tsunami, as is almost all of St. Lawrence's business and commercial activity (at least on the lower levels of their buildings) including its only bank and drugstore.

Certain facilities that potentially house people, or host crowded gatherings, are also vulnerable, namely the large Recreation Centre and the soccer field and its viewing stands that could seat several hundred; both are built on filled land in about the area of the original baymouth bar and tidal pond. Similarly the Golden Age Senior Citizens Club, the Oceanview Motel and Restaurant, the Harbourview Restaurant (presently closed) and the apartments under construction behind and below the restaurant, the Miners Museum, the 'DREE' [Central High] School on Highway 220, the St. Lawrence Town Hall and its contained Public Library with the Town's municipal garage and depot plus a water treatment facility to the northwest are all also vulnerable to a 1929-like tsunami. Of most concern should be the newly-constructed Mount Margaret [Senior Citizens] Manor off Memorial Drive (Map 2). The fish plant, when operating, and the DFO community stage on Water Street East both could have, at times, significant gatherings or workers. It does not appear from the existing data that the runup from a 1929-like tsunami could reach the U.S. Memorial Community Health Centre for longterm care at the northwest end of Memorial Drive at a height of about 28 m — some 15 m above the estimated 1929 tsunami runup limit.

Two automobile garages, including the only two St. Lawrence gasoline stations, are in the 1929 tsunami runup zone, as is the fire station at the site of the old town hall on Riverside Drive. At least the front access and parking area of the regional RCMP office on Water Street East are also in the 1929 tsunami runup zone.

If a 1929-like tsunami was to occur today, then all Riverside Drive, the northwest end of Water Street West where it joins to Pollux Crescent and becomes Water Street West Extension, much of Water Street East north of Mic Turpin's house (Map 2), the key regional link of Highway 220 from Mount Cecilia Catholic Cemetery west to Memorial Drive, the southeast ends of Memorial Drive, St. Cecilia Road and Park Lane, could all be blocked to traffic by tsunami-transported debris (Map 2). In the worst case, the Town's heavy machinery in the garage off Memorial Drive might be immobilized by tsunami flooding, and debris blocking roads might not be immediately cleared, thus access to critical facilities may remain barred for a number of hours — conversely, emergency vehicles at the fire station, at the U.S. Memorial Community Health Centre, or at the RCMP office may not be able to leave until the access roads are cleared of debris.

The potential for a 1929-like tsunami to flood onshore areas may have been enhanced by various

post-1929 changes that have been made to the tsunami's 'flood plain' in the 1929 runup zone. Large solid structures such as the fish plant on Shingle Point, the Alcan Wharf, the Minworth Pier, the Recreation Centre, the Central High School, the filled area that supports the Miners Museum, the newly-raised baseball and soccer field areas to the west of the southeast end of Memorial Drive, and the Town Hall/Library may not give way if a 1929-like tsunami were to reoccur. Instead, they will impede the tsunami's flow exactly as they would in a flood plain of a flooding river, and thus the further constriction may cause the tsunami's runup elevation to rise. These structures and their impediment will also take energy from the tsunami and contribute to slowing it down until the force of gravity eventually kills the tsunami's runup and it drains back to the sea.

The berm-like barriers of Causeway Road and Highway 220 will serve a similar role; the north end of Water Street West is too low to act as much of an impediment. However the large volume of the inward tsunami flow, or outward drainage, which will tend to follow the axis of Riverhead Brook, should be expected to remove the pedestrian bridge west of the drugstore and to erode, undermine, or remove the three road bridges crossing the brook on Highway 220, on Water Street West (the former Government Bridge that did go out in the 1929 tsunami), and on (Mannix) Causeway Road — thus isolating the west from the east side of St. Lawrence (Map 2) and breaking the regional Highway 220 connection along the South Coast. Perhaps one should also expect such a tsunami to possibly break, or to at least temporarily block with debris, Highway 220 at one spot in the Lewins Cove area east of St. Lawrence, at Taylor's Bay west of St. Lawrence, and in the low flat area at the head of Lamaline Harbour where culverts may be eroded over and above any blockage of the highway by debris (Figure 2).

Thus, an event equivalent to the 1929 tsunami could put a considerable number of persons, most of the businesses, and several important roads at risk. The St. Lawrence Emergency/Disaster Plan has no particular plan for a disaster of this magnitude or scope (Anonymous, 1992).

CONCLUSIONS

The November 18, 1929 tsunami height, the tsunami runup height, and the limits of the tsunami runup zone were recoverable in St. Lawrence, Newfoundland from the distance of just over 65 years, despite the general lack of a written record. These data could be recovered through the strong oral tradition in Newfoundland, along with certain limited written materials.

The tsunami height in the outer part of Great St. Lawrence Harbour is estimated to have been about 4 m, the tsunami runup height is estimated to be about 13 m, and the tsunami runup zone is thought to have extended about 760 m inland from the former baymouth barrier beach bar once known as 'the strand'. Such a tsunami height and runup, if repeated, would likely impact all fishing premises, almost all St. Lawrence's businesses, up to thirty residential homes, a pedestrian bridge, three road bridges and three main roads, the police (RCMP) and local fire

services, the Recreation Centre, sports fields, the high school, the water treatment facility, and the availability of most vehicle fuel in the community. A senior citizens home would be at risk; the U.S. Memorial Community Health Centre for longterm care probably would not be at risk and it might serve as a temporary evacuation centre during a possible future tsunami alert.

None of the emergency measures plans in place allow for a disaster of this magnitude — nor do any others in other Burin communities. There is, however, genuine interest in the 1929 type of tsunami risk within the community. In addition, the Mayor of St. Lawrence, as an active participant in the Greater Lamaline Area Development Association (GLADA), has a particular interest in having the Burin area document and interpret the 1929 'tidal wave' disaster as a possible topic of interest to an enlightened tourist traveller.

RECOMMENDATIONS AND DISCUSSION

In August of 1989 during my first extended visit on the Burin Peninsula, I went into the town hall of St. Lawrence, Newfoundland, and asked the staff person on duty if I could see 'the tsunami runup map for 1929'. "The what?" was the puzzled reply. "The 'tidal wave' runup map — the map of the area flooded by the 1929 'tidal wave' when it flowed inland," I explained. And I remember the reply, "We have got nothing like that." And nor was the 1929 tsunami runup zone a factor in the community's town plan at the time, and nor is it yet (W.B. Titford Limited, 1985 and 1991).

St. Lawrence has a series of town planning maps prepared by W.B. Titford Ltd. and Newfoundland and Labrador Consulting Ltd.; these are available from the Director of Urban and Rural Planning in the Department of Municipal Affairs in St. John's, as well as being available for inspection at the town hall. These maps deal with the conventional physical planning concerns, such as slopes, sanitary and storm drainage, land use planning, development control, and the like. The documents at no point allude to the severe flooding that occurred from the arrival of the tsunami on the night of November 18, 1929. There is no suggestion that certain lowland areas at the head of the inlet are perhaps unsuitable for building in a zone akin to a river's 50-year or 100-year flood plain. The effects of the serious 1929 tsunami have been lost on the modern-day planners as a lesson of Nature.

An analogy perhaps is to be found the Humber River Valley in Toronto where, in 1954, Hurricane Hazel's tremendous runoff caused severe flooding, property damage, and a large loss of life. Ontario and Metro Toronto learned the lessons which Hazel imposed in 1954 and, almost without exception, the river floodplains of the area are now prohibited areas for most construction. This has not been the response of planners in the Newfoundland Department of Municipal Affairs, or seemingly of planners in private practise, vis-à-vis the 1929 tsunami runup zone. Thus the Mount Margaret Manor senior citizens residential facility was very recently built within, or very close to, the probable 1929 tsunami runup zone, and the new apartments behind

and below the presently-closed Harbourview Restaurant on Water Street West have been permitted to be built, without impediment, despite being at a clear risk if a second, 1929-like tsunami were to occur.

The Town of St. Lawrence might well consider modifying both its 1991 *Town Plan* and its 1992 *Emergency/Disaster Plan* at the next possible opportunity to allow for the possibility of a repeat event similar to the 1929 tsunami.

If one were to ask any one of the RCMP officers who patrol the St. Lawrence area of the Burin Peninsula, "What would your detachment do if you felt a strong earthquake?" [as was felt at 1702 NST on November 18, 1929], the best response one probably can get is, "I'd stay tuned to the radio." I believe I am correct in saying that there are no RCMP, or local, evacuation plans for any part of any of the Burin communities in case of a tsunami alert triggered by a large felt earthquake. There is not any such plan for St. Lawrence. In general it is probably safe to say that the local authorities have no plan for what areas they might close off or evacuate — or for how long the closures and evacuations would last — if a large felt earthquake occurred and a tsunami alert were to be instituted in St. Lawrence.

In the case of St. Lawrence, with the RCMP and fire stations partly within the 1929 tsunami runup zone and susceptible to all their access roads being blocked by debris left by the tsunami, this concern is by no means academic. The potential problem is further compounded by the regular rotation of RCMP personnel, with replacements often being from other provinces of Canada where there is no longer any memory of the 1929 earthquake and tsunami. If local emergency measures personnel are to be able to adequately respond to a tsunami alert, one of the local agencies, such as a fire department, should assume the responsibility to sponsor a tsunami seminar, or exercise, as part of their regular emergency measures training program.

We do not know the probable return period of a 1929-sized magnitude 7.2 earthquake in the LSP Seismic Zone, or elsewhere along the continental shelf edge of Eastern Canada or of the United States. Nor do we know the probable return period of a 1929-like tsunami along the South Coast of the Burin Peninsula. However, we do know that in 1864, St. Shotts, Newfoundland experienced a tsunami and I have unpublished evidence that it was associated with a felt earthquake on the Avalon Peninsula. We do know that the area of southern Newfoundland, Saint-Pierre et Miquelon, and Cape Breton Island of Nova Scotia have all experienced a number of felt earthquakes whose epicentres were at sea, and there is even an unexplained small, apparent tsunami, that affected the northern tip of Cape Breton Island in 1914 (Ruffman, 1991b).

We also know that in the upcoming 1995 revision to the Building Code of Canada, the offshore LSP Seismic Zone is probably to be expanded somewhat in size to better allow for the known seismicity that seems to be emanating from some sort of a tectonic zone 20 ±2 km deep beneath the continental slope. This includes a 1989-90-91 swarm of small earthquakes that were detected only by instruments along the axis of the Laurentian Channel west of the current LSP

Seismic Zone. Ruffman and Adams (In Preparation) have suggested that these small events may have been caused by residual movement on one of the many salt domes in the Carboniferous rocks of the area.

The Geological Survey of Canada uses a probable return period of 100 years for a magnitude 6 event in the LSP Seismic Zone and it uses about 1,000 years for the return period of a magnitude 7 event. My work on historical seismicity may suggest a shorter return period (Ruffman, 1991b). While no-one can predict the time of the next magnitude 7.2 earthquake event or the next tsunami, it would be prudent to have the essential information available to the local police forces, volunteer fire departments, town planning officials and politicians to allow them to consider possible future emergency measures procedures. This analysis may encourage them to control highly susceptible land uses in the probable tsunami runup zone (eg. a future senior citizens home or a future recreation hall seating 300 to 400 persons).

It is reasonable to suggest that in the future if a strong earthquake is widely felt on the Burin Peninsula, the personnel responsible for emergency preparedness should automatically assume that, based on the 1929 experience, the earthquake epicentre is offshore and that the earthquake is potentially tsunamigenic until told otherwise by the Geological Survey of Canada in Ottawa. If a future tsunami originates at the shelf edge, or on the continental slope, similar to the 1929 location, then the historical evidence from 1929 indicates that those responsible for emergency measures on the Burin Peninsula have two to two-and-a-half hours to prepare before the potential tsunami arrives. This is sufficient time to evacuate all personnel from the probable tsunami runup zone, to move police, fire, ambulance and potentially important heavy equipment to high ground, and to close all susceptible roads. A watchperson with a portable radio could be posted in the vicinity of the Water Street West Extension on high ground to observe any significant and rapid change in the sealevel that heralds the arrival of a tsunami.

A tsunami alert, and the resultant evacuation initiated on feeling a strong earthquake on the Burin Peninsula, should be maintained for three hours after the strong felt seismic event is experienced. The Geological Survey of Canada in Ottawa should be able to confirm an offshore epicentre location (or not) within an hour. If contact can be made with the Bermuda tidal station, and if the Bermuda station reports that it sees no tsunami at the end of two hours after the strong felt event is experienced in southern Newfoundland, then probably the Burin will not suffer a tsunami. On the other hand, if Bermuda's tidal station does see a tsunami after two hours, then Burin officials should redouble their evacuation efforts. Parts of Bermuda did observe the 1929 tsunami within two hours of the felt earthquake, though Bermuda had no tide gauge at the time to record the tsunami; the 1929 tsunami arrived along the coast of the Burin two-and-a-half hours after the earthquake was felt.

By the same token, if the Teleglobe Canada shore station located in Sambro Creek, Halifax County, Nova Scotia, can be contacted immediately after a large felt seismic event is experienced in southern Newfoundland, one may get an immediate indication that the earthquake was an offshore tsunamigenic event. If Teleglobe Canada experiences an interruption or break of any of their transAtlantic telephone cables at the time of the felt earthquake, or thereafter, this

may indicate that parts of the ocean floor have moved, or are moving, and that a tsunami may have been generated. With such a message from Teleglobe Canada, Burin emergency measures officials should redouble their efforts on the assumption that the cables broke because either a seafloor rupture occurred during the earthquake, or because an earthquake-induced slump occurred, setting up a turbidity current — as occurred in 1929.

The approach taken in this assessment and mapping of the 1929 tsunami in St. Lawrence, Newfoundland, can be applied elsewhere where similar types of events have occurred within the time limits of community memory. This is the first time in Canada that oral history techniques have been used to document a historic tsunami; it could still be applied elsewhere on the Burin, or to other similar events. The present-day communities of Port au Bras, Lord's Cove, Taylor's Bay, Point au Gaul, and Allen's Island on the Burin Peninsula all suffered deaths in residences during the 1929 tsunami and all today have residences lying in their respective 1929 tsunami runup zones. About forty other Burin communities made damage claims after the 1929 tsunami. Only the tsunami runup zone of Taylor's Bay has been documented in reasonable detail (Ruffman and Tuttle, 1995; Tuttle *et al.*, 1995) with some work by the author in Port au Bras (Ruffman *et al.*, 1989). Clearly the oral history database on the 1929 tsunami in these communities is continuously being lost through the loss of older residents and, in many cases, the community knowledge is already becoming second-hand. There are other examples in Canada where the oral history approach can be considered.

Shortly after the March 27, 1964 Alaskan earthquake, in the dead of night, Port Alberni and the whole of the Alberni fjord was struck by several pulses of a significant tsunami. In correspondence with the planning authorities of the area, I have established that there is no detailed report on the tsunami, its damage, the tsunami height, or its runup zone. There is some active municipal consideration being given to imposing floodplain controls via zoning changes but these will be done in the absence of any careful documentation of the 1964 event. The same techniques as used here could be used in the Alberni fjord with even more success and detail, since memories will be greener and a fine post-tsunami photographic database exists.

The same methodology could well be applied, but with much more difficulty because of the sparse population, to the rather curious, large-amplitude, tsunami-like waves which struck the northern Queen Charlotte Islands in late March 1963. These waves may have been responsible for the death of a Jedway man. Similarly, quite significant, seiche-like events have struck Lake Erie in 1926, Lake Ontario on May 23, 1925 (and in 1912 and 1913) and Lake Superior in 1933. Few of these events have been documented and historical and oral history techniques may be the only way of capturing any information. Two such events in the lower Great Lakes have cost up to 13 lives in one incident and two in another.

The methods developed in the contract will also serve to document storm surge events or certain other atmospherically-induced seiche-like events. One such event in Lamaline, Newfoundland on Christmas Day 1983 probably rose higher than the 1929 tsunami and occasioned fire department rescues by boat. Another violent storm and 'tidal wave'-like or seiche-like event affected the east coast of the Avalon Peninsula, in particular Brigus South, Petty Harbour, Bay

Bulls, Bauline and La Manche on January 28, 1966. Again, no scientific documentation is available and one can only rely upon carefully gathered oral history. A house was slightly rotated in La Manche and one was floated right away from its foundation in Brigus South (Gail Catto, Department of Geography, Memorial University of Newfoundland, personal communication, March, 1994, from her oral history work for an M.Sc. thesis). Virtually all the fishing premises in La Manche were destroyed and the community never recovered; it was relocated shortly afterwards.

Placentia Bay and the Avalon Peninsula of Newfoundland seem particularly susceptible to certain storm surge events and there is a developing record of a series of such events back to September 11-12, 1775 when a major hurricane caused a great loss of life in Newfoundland and Saint-Pierre et Miquelon (Ruffman, 1995; 1996). Similar storm surge events have caused significant modern flooding in at least the community of Placentia, Newfoundland (eg. at least on February 3, 1904; October 10, 1944; September, 1955; Winter, 1960; March 8, 1976; January 20, 1977; January 10 and 16, 1982; December 22 and 25, 1983; January 5, 1989). These events collectively could have been documented by town officials just after they occurred; they generally were not — the approach seems to have been, like in Port Alberni in March-April of 1964, 'clean up the mess and get on with life'. A good oral history in Placentia would allow the areal extent of these storm surge events to be mapped.

Another such event that is highly amenable to documentation by the methodology used here is the Monday, February 2, 1976 Groundhog Day storm in southeast Nova Scotia. It is the author's view that it is also well worth attempting to use the limited surviving historic information to try to document the extremely high flooding limit of the October 4, 1869 'Saxby Gale' all around the Bay of Fundy. This hurricane and its very high storm surge fortuitously occurred during a very high spring tide and probably will stand as the highest water level ever recorded in the Bay of Fundy. The effects of such a storm surge today, 125 years later, would be much more pronounced, yet no maps exist to illustrate the 1869 event's effect for planners and emergency measures personnel.

The use of the collective community memory integrated with surviving documentation to document historic high water events (tsunamis, seiches, storm surges, or river flooding) is a technique that should be considered in all parts of Canada. The use of such a methodology and its conversion to actual water level heights on contoured community topographic maps will give the land use and emergency measures planners, politicians, and emergency measures personnel real data that can be tied to new zoning maps, insurance schedules, community road maps, and ultimately to evacuation plans and safe evacuation routes.

ACKNOWLEDGEMENTS

In a project of this sort the database has depended upon the collective memory of the community, and it is to the residents of St. Lawrence that my first acknowledgement should go. My interviewees were key to the process; in chronological order they were, Charlotte Turpin,

Pauline Loder, Michael Turpin, Archibald Slaney, Gertrude and Norbert Turpin, Blanche and her son Levi Pike, Elizabeth Slaney and John Kelly. I also drew important data from local citizens interested in their local and family history; these included the published author Ena Farrell Edwards, Kevin Pike and John and Emma Cusick (all of whom also assisted by providing documents, photographs or references for use in the report in the Appendices volume). Richard Clarke of Little St. Lawrence, Christina Keating of Lawn, Cathy and Ron Way of the Salt Cove Brook B&B, Bud Giovannini of the Oceanview Motel, Edgar King and Annie Hillier of GLADA, Adolph Handrigan, Meta Turpin of the Public Library, all were helpful along the way.

I should also thank St. Lawrence Mayor Wayde Rowsell and his Council for their initial interest and for a series of suggestions of sources, made at a meeting as I first entered the community. The town clerk Greg Quirke and his staff person Eileen Norman were particularly helpful in obtaining copies of reports, answering questions, and permitting the Albert J. Wallace photo album to go out for Cynthia Farrell of Farrell Foto to duplicate a number of the photographs. Paula Levy and George Macvicar of *The Southern Gazette* have been interested in the 1929 events for some time and gave the St. Lawrence project coverage in the March 7, 1995 issue (Vol. 19, No. 38, pp. 3 and 4). Evelyn Grondin of the Burin Heritage House provided a respite from the near continuous snow and 'glitter' storms.

It is also fair to say that this project has built on the shoulders of, and came out of, my earlier 1929 tsunami projects. My initial interest was spawned by a project sponsored by the Earth Physics Branch of the Geological Survey of Canada in Ottawa, followed by another sponsored by the Canadian Hydrographic Service at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. The tsunami-laid deposits work in 1993 and 1994, which included my first oral history work with older residents and my first contact with St. Lawrence residents, was sponsored by the United States Nuclear Regulatory Commission which has an interest in, and concern with, large earthquakes vis-à-vis nuclear power plants. The Royal Canadian Geographical Society sponsored my November 1994 Newfoundland lecture tour on the 65th commemoration of Canada's most tragic earthquake, and this two-week period on the Burin Peninsula provided an opportunity to establish more contacts in St. Lawrence and to do my first two oral history interviews in the community. It is also fair to say that this project has spawned some new ideas as well, and I will return to St. Lawrence in August of 1995 to search for the onshore geological signature of the 1929 tsunami along the axis of the tsunami runup zone in the meadow northwest of the Bank of Nova Scotia west of Riverhead Brook.[31]

Finally, this project would not have come about if it were not for the initiative of David H. Snow of St. John's who, as Regional Director of Newfoundland for Emergency Preparedness Canada, caught the ball I tossed and ran with it. Mr. Snow spotted a November 21, 1994 article in *The Evening Telegram* of St. John's that had come out of my November lecture tour on the Burin Peninsula and had delved into his memory of some earlier related correspondence which we had had on the 1929 earthquake, located me in Halifax, and initiated an inquiry. Mr. Snow then took my suggestions to the Emergency Preparedness Canada head office in Ottawa. From there, it was Dr. Chris Tucker, Director of Evaluation and Analysis, and Yves Lord as Scientific Authority, who saw the suggestions into a contract.

It was also Dr. Tucker and Mr. Lord of Emergency Preparedness Canada who persevered with, and endured, the delays that I imposed on the final report. I trust that they feel the results were worth it and that they will continue their interest in the 1929 and other tsunami events and in the potential of the process of using a community's collective memory to reconstruct and to map similar historic disasters as a planning tool to prepare the community for the next such possible event.

TABLE 4

List of existing businesses, agencies, homes and facilities that may be at risk if a 1929-like tsunami is repeated in St. Lawrence, Newfoundland

Number on Map 2	Name	Location	Comment
1.	Fish plant and employee parking lots	Shingle Point	Presently closed.
	three residences	southeast end of Water Street West	Located on the water side below the street level.
2.	Farrell's Food Town and clothing, furniture (downstairs) Farrell Brothers Ltd.	Water Street West	Upper floor may be OK, storage in lower floor susceptible.
2.	Reed Stenhouse Ltd. Insurance Brokers	Water Street West	In same building as Farrell's Food Town.
3.	Alcan Wharf	Water Street West	Not presently in use for fluorspar ore shipment.
4.	Office of the Northern Cod Adjustment and Recovery Program (NCARP)	Water Street West	Office at street level, may be OK.
5.	Edwards Take Out	Water Street West	At street level, may be OK.
6.	Minworth Pier and Government Wharf, large storage shed for fluorspar ore	Water Street West	Not presently in use for fluorspar ore shipment.

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment
7.	former Farrell furniture and clothing store	Water Street West	Vacant at present.
8.	Aylwards Home Hardware	Water Street West	Main hardware at street level may be OK, storage on lower floor susceptible.
8.	Aylwards furniture department	Water Street West	All on lower level, all susceptible.
8.	Aylwards Supermarket	Water Street West	Main store at street level may be OK, storage on lower floor susceptible.
9.	Oceanview Motel and Restaurant	Water Street West	Accommodation on upper levels; restaurant, kitchen and bar on lower levels; juts out into harbour and may be susceptible to being washed away. The parking lot is close to sealevel.
10.	storage building owned by Aylwards	Water Street West	Vacant? at present.

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment
11.	Harbourview Restaurant & Take Out with apartments under construction behind and at a lower level than the restaurant	Water Street West	Presently closed. The apartments are close to sealevel.
12.	Food Stop, G & E Convenience	Water Street West	In the location of the Cusick two-storey house which was moved in 1929.
13.	Em's Take Out (Kettle's)	Water Street West	In the location of the postal/ telegraph office which was moved in 1929.
	about twelve residences	foot of Notre Dame Street at Water Street West	In 1929 tsunami runup zone, one residence moved here in 1929.
14.	former Newfoundland Liquor Corporation store	Water Street West	Presently closed, the service is now in the pharmacy.
15.	Bank of Nova Scotia	Water Street West	Right on the axis of the tsunami runup.

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment
16.	St. Lawrence Golden Age Senior Citizens Club	Water Street West	Close to Riverhead Brook; right on the axis of the tsunami runup zone.
	Herring Cove wharves	at southeast of Water Street East	Would be flooded.
17.	Canada Dept. of Fisheries and Oceans Community Stage	Water Street East	Would be flooded and the building is at risk of being swept away.
18.	Pike's Garage	Water Street East	Repairs only, no gasoline sold; very close to sealevel. All buildings here were swept away in 1929.
19.	Lambe's Riverhead Take Out & Games Arcade	Water Street East and Mannix Causeway Road	Very close to sealevel. All buildings here were swept away in 1929.
20.	Stella Maris Hall and Club	Water Street East	Building is above the 1929 tsunami runup zone but the parking lot is not, and it is close to sealevel in part.
21.	Aylwards Mini Mart Ltd. and original shop directly to the southeast	Water Street East	Close to sealevel

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment
22.	St. Lawrence Recreation Centre and St. Lawrence Soccer Association	Water Street East in filled area of former tidal pond and built on the area of 'the strand'	Very close to sealevel.
23.	former Chicken and Rib Hut	Mannix Causeway Road	Presently vacant, on seaward side close to sealevel.
24.	Canada Post Corp. Post Office	Water Street East	Building may be above the 1929 tsunami runup zone, the parking lot is not.
25.	Royal Canadian Mounted Police regional office and its access	Water Street East	Building is partly in 1929 runup zone. Parking lot and access are in the runup zone.
26.	St. Lawrence Fire Department and its access (old town hall)	Riverside Drive and on the axis	Very susceptible, close to sealevel of the 1929 tsunami runup along Riverhead Brook.
	six residences	Riverside Drive along side of Riverhead Brook	All close to the axis of 1929 tsunami runup. Two houses moved here in 1929.
27.	St. Lawrence Pharmacy	Riverside Drive	Building and parking lot are susceptible.

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment
27.	Sears Office	Riverside Drive	In the pharmacy.
27.	Newfoundland Liquor Corporation outlet	Riverside Drive	In the pharmacy.
28.	Irving gas station	Riverside Drive	Building and gasoline pumps at risk.
29.	Video Corner	Riverside Drive	Backs onto Riverhead Brook, in the axis of the 1929 runup zone.
30.	Miner's Museum	Riverside Drive and Highway 220	Lawn of filled land might protect the building.
31.	Mount Cecilia Catholic Cemetery	Highway 220 and St. Cecilia ('West Brook') Drive	Land elevations not changed since 1929. The tsunami entered the graveyard and toppled some headstones in 1929.
	eight residences	Park Lane	All on the axis of the 1929 runup though it is not certain how far north of the present Highway
		220 the tsunami	ran. Its depth was only about 1 to 2 m in this
		area.	

TABLE 4
(continued)

Number on	Name	Location	Comment

Map 2			
32.	Central High School "The DREE School" and parking lots	Highway 220	The tsunami depth was only about 1 to 2 m in this area.
33.	Town Hall, Public Library, St. Lawrence Heritage Society offices; Truxton and Pollux plus the miners' memorials located outside	Highway 220	The tsunami depth was only about 1 to 2 m in this area.
34.	Aylwards Building Supplies, office and yard, Come by Chance gasoline pumps at Aylwards Petro Service	Highway 220	The tsunami depth was only about 1 1 to 2 m in this area.
35.	new soccer field	Memorial Drive and Highway 220	The tsunami depth was only about 1 to 2 m in this area. The new fill to level the field may fully protect this area.
36.	St. Lawrence Town Council garage and equipment depot	Memorial Drive	The tsunami depth was only about 1 to 2 m in this area.

TABLE 4
(continued)

Number on Map 2	Name	Location	Comment

37.	Mount Margaret Manor Burin Regional Personal Home Care Ltd., plus parking lot and access road	Memorial Drive in this area.	Fronts onto Riverhead Brook, access road crosses the brook. The tsunami depth and current in 1929 very low
38.	U.S. Memorial Community Health Centre for longterm care and its access road	northwest end of Memorial Drive	This new facility is above the 1929 tsunami runup zone. Its access road is not.
39.	culvert on driveway	off Memorial Drive	Leads to Mount Margaret Manor.
40.	culvert on road	St. Cecilia Drive on West Brook	Leads to West Brook Road and watershed.
41.	bridge on highway	Highway 220 'The Lawn Road'	The Burin Peninsula Highway links all communities.
42.	the 'Government Bridge'	on Water Street West at Riverside Drive over Riverhead Brook	This bridge went out in 1929.
43.	bridge over Riverhead Brook	On Mannix Causeway Road	This marks the end of Riverhead Brook as it enters the inner harbour.
44.	Pedestrian Bridge	Riverhead Brook	West of pharmacy.
45.	Water treatment facility	Memorial Drive	Near the runup limit of the 1929 tsunami.

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