

The 1983 Charlevoix  
microgravity survey.

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## INTRODUCTION

The 1983 microgravity survey in Charlevoix was done by contract and was awarded to Terra Surveys of Ottawa. The network was expanded on the South shore of the St Lawrence river and a total of 33 sets of ties were measured successfully. Four observers participated in the June and October portions of the survey with little decrease in the quality of the results.

## THE NETWORK

This was the year that the Branch expanded its network in Charlevoix and added five more gravity stations on the opposite side of the St Lawrence river. This increased the number of ties from 27 to 33 sets of gravity differences and added considerably to the number of miles travelled by the observers.

The new stations on the South shore of river were St Cyrille de Lessard (905183), Pointe aux Orignaux (905283), Eatonville (905383), Mont Carmel (905483), and Andreville (905583). They were installed early in June, 1983, just before the start of the survey which began on the 13th of the month with the calibration of the instruments.

## THE SURVEY

The Ottawa-Gananoque calibration was done by the crew of Terra Surveys Ltd, following a brief initiation to our gravimetry procedure. The observers performed fairly well although extra ties were needed to satisfy our quality control.

After they were shown around the two parts of the network in Charlevoix, on the 18th and 19th of June, the observers proceeded to measure their first set of ties. They executed the survey under supervision, until the 21st of June, to see if any problems might arise.

A return visit to the area was needed on the 5th of July to monitor their progress and also to identify which sets of ties needed repeating. The crew had received instructions to wait for a visit before crossing to the South portion of the network since repeated travel between the two sides of the river would slow down their survey. They executed the ties on the South shore from the 7th to the 10th of July, and returned to Ottawa in order to recalibrate the gravimeters on the 11th and 12th.

Terra Surveys Ltd delivered their interim report on the 19th of the same month.

The repetition of the survey occurred from the 12th of October to the 15th of November, including the calibration of the instruments before and after the survey.

The survey supervision took place between the 17th and the 21st of October, and the visit was used mostly to help a new observer overcome some instrument difficulties.

The company handed in its final report in early December and it was decided that we did not need a post-survey meeting.

#### DIFFICULTIES

The wording of the contract caused some problems, namely the estimated road distances to travel during the survey. Not having surveyed the South portion of the network ourselves, we underestimated the total number of kilometers.

Instead of 6500 km, each vehicle had to cover about 9000 km in the network alone. This lengthened the survey period for each of the June and October phases and created delays when bad weather set in during the early part of November.

Although the South portion of the network has the advantage of a fast highway (# 20), the total length of the network exceeds that of the North portion! Some ties were so long that it generally took a day to measure them, and thus the "standard" of two ties per day could not be applied. The crew decided on one occasion to use only one car since it would save gas even though the second observer had to wait for the first one to take her reading. It was found that the six ties of the South network took five days to measure.

Few instrumental problems occurred except for the difficulties the crew had in obtaining good standard deviations with D27 compared to D06. The drift rate due to unclamping the former instrument seemed to have been a source of error, as small dial deflections sometimes were translated into large ammeter changes away from the null.

Thus, the greater overall error of the October gravity adjustment seems to have been caused by D27. Indeed, the standard deviation of the residuals for D27 were 9.5 microgal in June and 10.5 microgal in October.

During the October survey, the crew made the classic mistake of charging their meters overnight on a switched electrical outlet. They woke up with cold meters and they were forced to wait 24 hours in order to stabilize the instruments before returning to the survey.

Seismic activity was a big problem in the October survey as the crew lost 5 days of survey work due to teleseisms. Microseismic activity was also noticeable for many days during the same month: ammeter oscillations were of the order of +/- 15 microamps on the most sensitive scale.

The June survey suffered a long heat spell which seemed to have influenced D27's cycling circuit. However, there was no conclusive proof that external heat was the source of large standard deviations.

The crew was challenged on a few occasions by "irate" owners who seemed to have forgotten that we have surveyed the area twice a year for the past seven years. There must have been some change of ownership in a few instances, but for the most part, it was basically bad communication between husband and wife on the one side, and the Branch and the owners, on the other side. The Branch handed the crew letters of introduction and EPB pamphlets describing the work that we are doing in Charlevoix. This helped greatly in improving feelings toward the survey crew and their work.

In June, the crew was worried about accident prevention near the stations that are located close to the road. Hence, in October, the Branch provided the surveyors with road signs that warned motorists of "Survey crew ahead". This will now be part of our standard package of equipment that we lend to the contractor for our microgravimetry surveys.

#### SURVEY RESULTS

Table 1.  
Gravity values from network adjustments (milligals)

Station	June-July	S.E.	Octo-Novem	S.E.
905183	980701.383	2.5	980701.389	2.8
905283	---789.139	2.0	---789.137	2.3
905383	---707.693	2.0	---707.694	2.3
905483	---731.318	2.4	---731.315	2.7
905583	---804.893	fix	---804.895	fix
906176	---752.559	2.6	---755.566	2.9
906276	---741.716	2.7	---741.728	2.9
906376	---753.070	2.6	---753.067	2.8
906476	---733.858	2.5	---733.857	2.9
906576	---748.030	2.6	---748.034	2.6
906676	---756.741	2.4	---756.738	2.8
906776	---733.994	2.3	---733.992	2.7
906876	---776.488	2.2	---776.489	2.5
906976	---748.581	2.2	---748.573	2.3
907076	---776.204	2.0	---776.202	2.2
907176	---801.589	2.0	---801.585	2.3
907276	---755.400	fix	---755.400	fix
907376	---802.843	1.7	---802.845	1.6
907476	---814.378	1.7	---814.370	1.9
907576	---783.506	1.9	---783.503	2.1
937180	---703.437	2.6	---703.441	2.8

Table 2.  
Adjustments statistics  
(milligals)

	June-July	Octo-Novem
STD	0.0100	0.0114
CHI sqr	8.73	13.68 (13 deg. of fr.)
SD D06	0.0092	0.0085
SD D27	0.0095	0.0105
READINGS	632	634
REJECTED	16	6

Tables 1 and 2 give a quick overview of the survey results and the level of quality obtained. The table of statistics clearly shows that, although the same number of readings were taken, the overall quality decreased in October as stated earlier. The standard errors listed next to the gravity values in Table 1 are generally higher in the October-November survey than in the June-July one. The instrument D27 seems to be the source of the worsening results even though the quality of D06 improved in the second survey.

Except for a few stations, most gravity values have not changed significantly between the two surveys (Table 1). On both occasions, a few ties were made by ferry between stations 907576 on the North shore and 905583 on the South shore in order to get approximate gravity values for the South stations. We notice that, although station 905583 is indicated as "fixed" in two adjustments, its given gravity value changed by two microgals from one survey to the other. In the adjustments, this station had been allowed to "float" before being removed as an unknown ("fixed"). Thus, the final adjustment had two stations fixed instead of the usual one reference.

Station 937180 has also not varied by much. It is located in a remote spot NW of the main North-shore network. It has been our unofficial reference to help us detect network-wide changes since October 1980.

Stations that have changed appreciably are 906276, 906976, 907476, and to a lesser extent, 906176. The first and the last of these points are located on the SW end of the network and have behaved similarly in the past. We may have to study these changes more closely and compare them with the 1977 "anomaly" where the stations in that area had decreased in value as a group.

#### FUTURE PLANS

A shift in direction was decided January 1984 in which we

announced that we would not repeat the survey the same way as before. Indeed, the two phase approach was abandoned in favor of a greater effort in one survey in the middle of the year. We have acquired, we think, sufficient knowledge of the seasonal effects on the gravity network in order to forgo further repeat surveys within the same year. We plan to tie both networks on either sides of the St Lawrence River, by helicopter with a minimum of three sets of gravity differences (Figure 1.). This will strengthen the structure of the overall network and help us cover a wider area.

Furthermore, we will execute the gravity measurements with three instruments for the first time. Since this means extra hours in the field, we will remove some ties from the previous structure of the network and measure fewer differences between any pair of stations (6 vs 8). Special attention was given to the very long road ties and we eliminated most of them from the North portion of the network. Unfortunately, nothing could be done to the South portion except remove one station altogether (905483). This will save only one tie but will cut the survey time by half a day at least.

In order to help in our public relations with the population of Charlevoix, we will visit most owners prior to the survey so that we can obtain permission to go on their properties. On six occasions, they will be asked if a helicopter can land for one or two days. In addition, the contractors will be asked to get from these people the same permission in writing so that we know that there has been no change of heart after our initial visit.

The quality control will be changed somewhat so that it can accommodate the use of three instruments which will measure fewer ties each. The quality control statistics will thus take the instrument results as a group instead of individually. Moreover, loop closures which were used as another control when we used to instruments, will not be considered during this survey. We hope that with the use of more instruments, loops composed of many sets of ties will close more easily as instrumental discrepancies are averaged out.

We hope that this change in our method will prove successful and that we will be able to apply it in the future to our other network in Vancouver Island.

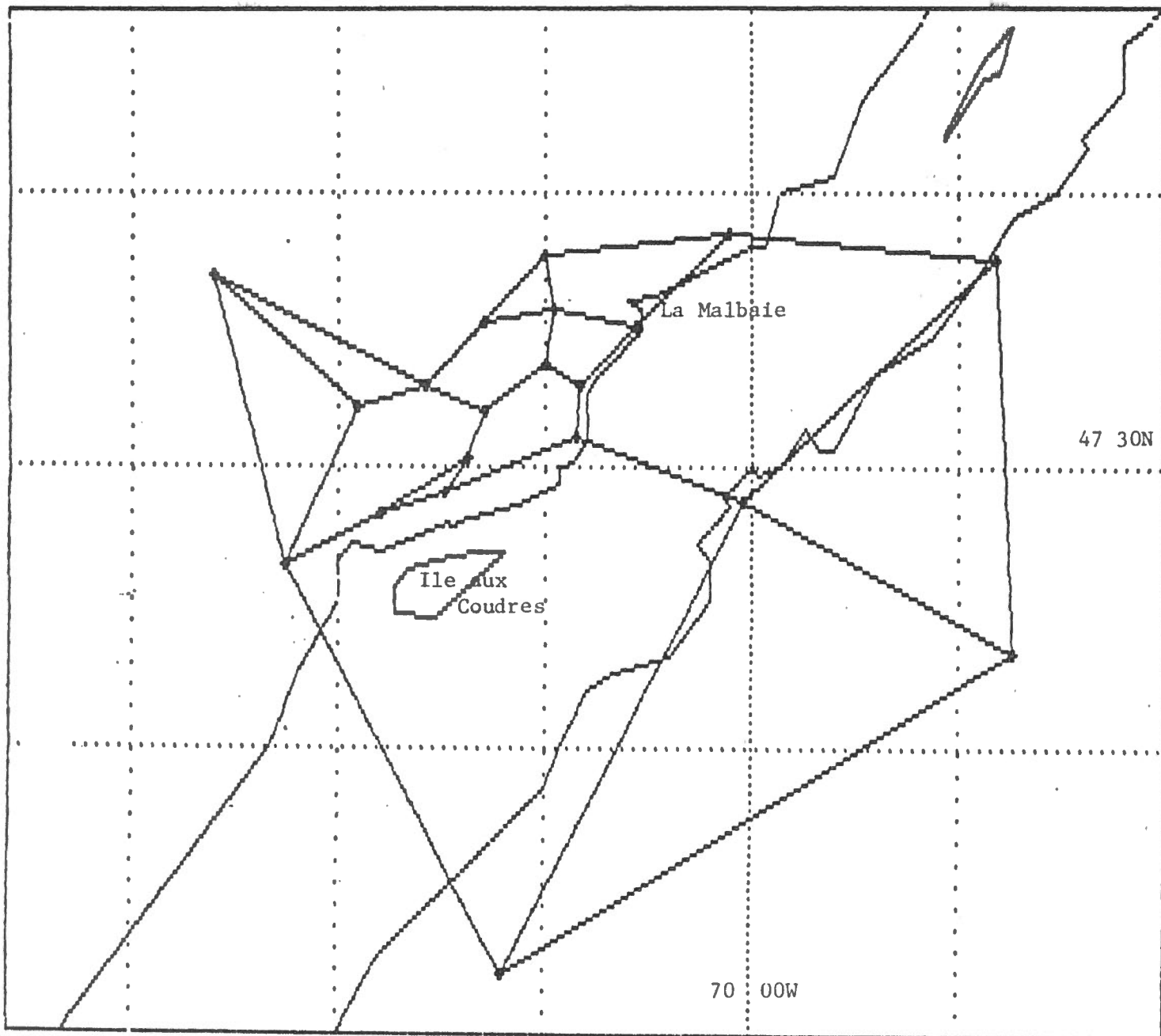


Figure 1.

Charlevoix network with the new stations  
on the South shore of the St Lawrence River  
with the proposed 3 airborne gravity ties.