RELATIVE GRAVITY MEASUREMENTS IN ILULISSAT IN JULY 2013

Final Report

June 15, 2015

Prof. Dr. Olivier Francis
University of Luxembourg
Faculty of Sciences, Technology and Communication
Campus Kirchberg
6, rue Coudenhove-Kalergi
L-1359 Luxembourg
Grand-Duché de Luxembourg

Tel. : +352 46 66 44 6264, Email : olivier.francis@uni.lu

Foreword

This report contains the results of relative gravity measurements carried out in Ilulissat (Greenland) in July 2013. It was done in conjunction with the first absolute gravity measurements at the Ilulissat airport with the FG5X-216 from the University of Luxembourg. This station was established by Emile Nielsen from the Technical University of Denmark (DTU) in 2009 and repeated in 2010 with the absolute gravimeter A10-019.

René Forsberg kindly provided us with the gravity station descriptions from the National Gravity Net. We present the results of the vertical gravity gradient at the absolute gravity station and the gravity ties from that station to four stations from the National Gravity Net. We are grateful to René Forsberg and Emile for their kind and friendly cooperation.

1. Vertical Gravity Gradient

The vertical gravity gradient was measured at the absolute gravity site in the airport hangar. We measured the gravity differences between three different levels (0.260 m, 0.861 m and 1.263 m) above the benchmark (Figure 1). We obtained a linear vertical gravity gradient of -3.128 +/- 0.012 microGal/cm.

Figure 1. Vertical gravity gradient measurements with Scintrex CG5 at the absolute gravity station in the airport hangar in Ilulissat.

2. Relative measurements

Relative gravity measurements were carried out with the Scintrex CG5-010 from the University of Luxembourg. The base station of the network is the new absolute gravity station at the airport, named "00001".

Four gravity stations (58201, 58801, 58802 and 58803) from the National Gravity Net were visited (see Figures 2 and descriptions in the Annexes).

It was important to find the gravity station 58801. This station was measured with the Jilag-3 absolute gravimeter in May 17-18 1988 by the Hannover team (Timmen et al., 2008). Measuring the gravity difference between the new and the old absolute gravity stations allow us to connect the absolute measurements from 1988 with the ones of 2013. The building was still standing. However, the floor has been covered with laminated parquet just a few years ago. The room is now used as a canteen. One of the employee confirmed that the marker was left in place. We estimated the location of the marker based on the information we had (see Annexes). We added 2 cm to our reference height to take the thickness of the parquet into account.

In addition, the gravity point close to the permanent GPS station along the runway at the airport was also measured (named "00002").

Unfortunately, the gravity station 59101 at the Ilulissat hotel was not found due to recent remodelling of the hotel.

Station 00001: absolute gravity station at the Ilulissat Airport

Station 00002: Permanent GPS at the Ilulissat Airport.

Station 58201: Ilulissat Churh.

Station 58801: Ilulissat Airport.

Station 58802: old absolute gravity station.

Station 58803: old absolute gravity backup station.

Figures 2. Gravity stations of the relative network measured in Ilulissat.

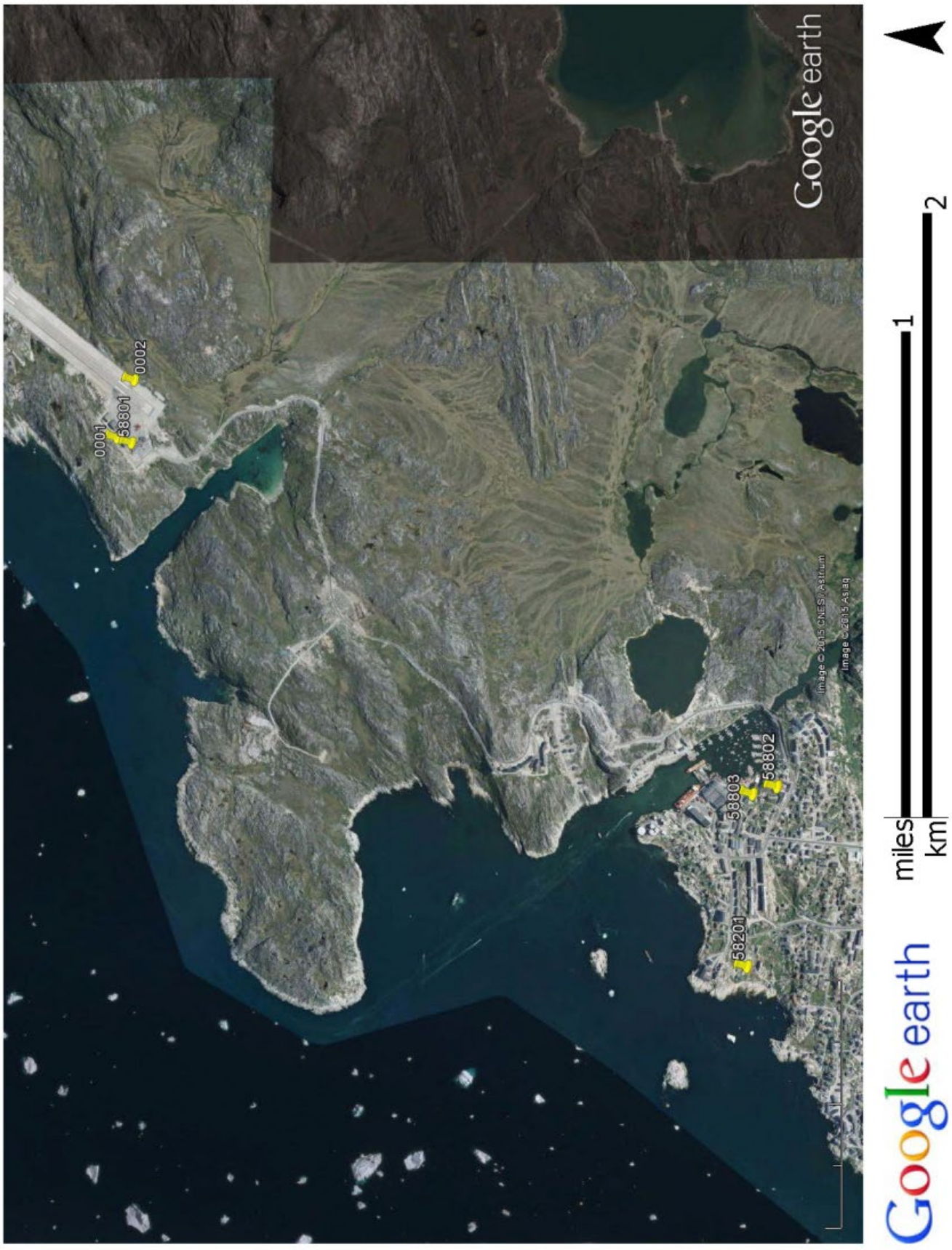


Figure 3. Locations of the gravity network sites measured in Ilulissat.

First, we measured the gravity differences from the new absolute gravity station and the stations 58801 and 00002 in the airport area. Then, we measured the differences between the station 58801 and stations 58802, 58803 and 58201. The results are presented in table 1.

Table 1. Measured relative gravity ties in Ilulissat in microgal.

Station	00001	00002	58801	58802	58803	58201
00001		-170.1 ± 3.7	+41.6 ± 3.3			
00002						
58801				-3567.97 ± 1.8	-2036.6 ± 1.0	-1572.1 ± 1.6

We can then calculate the gravity differences of each station with respect to the absolute gravity station (Table 2).

Table 2. Relative ties in Ilulissat with respect to the new absolute gravity station at the airport.

Site	Code	Lat	Long	Altitude /m	Δg /microgal	RMS microgal
New absolute site at the airport	00001	69.2410	-51.0661	16	0	
Permanent GPS site at the airport	00002	69.2404	-51.0607	33	-170.1	3.7
Church	58201	69.2199	-51.11010	2	-1530.4	3.7
Airport	58801	69.2406	-51.0664	17	+41.6	3.3
Old absolute gravity site	58802	69.2193	-51.0943	28	-3526.4	3.8
Old absolute gravity backup site	58803	69.2110	-51.0951	23	-1995.0	3.4

In 2013, we found a gravity difference between the stations 58802 and 58801 of 1531.4 +/- 5.1 microgal. It perfectly matches the value of 1531.0 +/- 7 microgal of 1988.

Now, we can use the absolute gravity measurement value obtained at the station 00001 in 2013 to deduce the gravity values at the other stations (Table 3).

Table 3. Gravity values at the National Gravity Net stations in Ilulissat.

Station	g /microgal	Uncertainty /microgal
00001	982 486 846.0	2.0
00002	982 486 675.9	4.9
58201	982 485 315.6	4.9
58801	982 486 887.6	4.6
58802	982 483 319.6	5.0
58803	982 484 851.0	4.7

Conclusions

In July 2013, four National Gravity Net stations from Ilulissat have been re-measured with a direct connection to the new absolute gravity station at the airport. The derived absolute gravity values have been calculated at those stations. Interestingly, we found the same gravity difference (at the microgal level) between the old absolute gravity station and its backup site as measured in 1988.

References

Nielsen J. E., Absolute gravimetry - for monitoring climate change and geodynamics in Greenland, Ph. D. Thesis, DTU Space, (ISBN: 978-87-92477-19-4), pages: 152, 2013.

Timmen, L., Gitlein, O., Müller, J., Strykowski, G. and R. Forsberg, Absolute gravimetry with the Hannover meters JILAg-3 and FG5-220, and their deployment in a Danish-German cooperation, Zeitschrift für Vermessungswesen (zfv), Heft 3/2008, 133. Jahrgang, S. 149-163, 2008.

ANNEXES - Gravity station descriptions

Station Nr. 58201 Jakobshavn Kirke
(EPB 9125-82)

Beliggenhed: Geografiske koordinater (hele sek.).
Bredde: 69°13.26'N. Længde: 51 06.92' W. Kote: 11 m.

Journalside: 41204, 41254 Måleår: 1982 Observator: RF, KE, PW

Afmærket på foto	rute	billede		rute	billede
Lodfoto 1:150 000			Skråfoto		
—	—		—		
— 1:50 000			—		
—	—				
—			Terr. foto	nr. 8221 - 9, 10	
—			—		

Etableringsform:

Bronzeplade	☐
Bolt	☐
Boret hul	☐
Anden:	
Ingen	☒

Signalering:

Varde	☐	m
Pille	☐	m
Stang	☐	m
Terrænsignal	☐	
Anden:		
Ingen	☐	

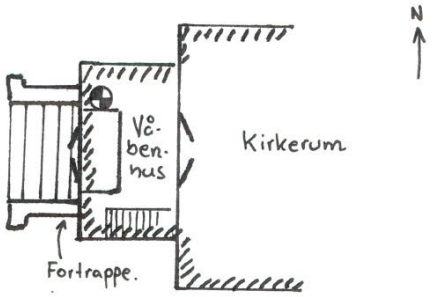
Naturligt fixpunkt:

Observationer:
Astro ☐ Doppl ☐ Trig ☐ Baro ☐ Grav ☒ Vandst ☐ Niv ☐

Supplerende oplysninger (skitser, opstigning etc.):

Jakobshavn Kirke. Til venstre inden for døren på betongulv, niveau 26 cm over øverste trin på fortrappen. 30 cm fra kanten, 220 cm fra våbenhusets nordside.

Jakobshavn church. On concrete floor to the left inside the doors in the porch. 30 cm from the wall, 30 cm from the edge and 220 cm from the north wall of the porch.



GREENLAND

NATIONAL GRAVITY NET

NAME

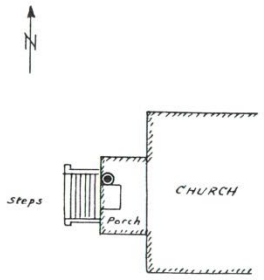
JAKOBSHAVN

EARTH PHYSICS BRANCH CANADA Number 9125-82

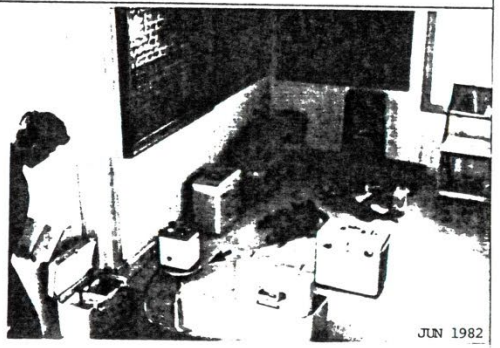
GEODETIC INSTITUTE DENMARK Number 58201

The station is located in the porch entrance to the church, just inside the doorway and N of the recessed entrance portal. It is 50cm N of the well wall and 30cm E of the W wall. The station is not monumented.

JUN 1982



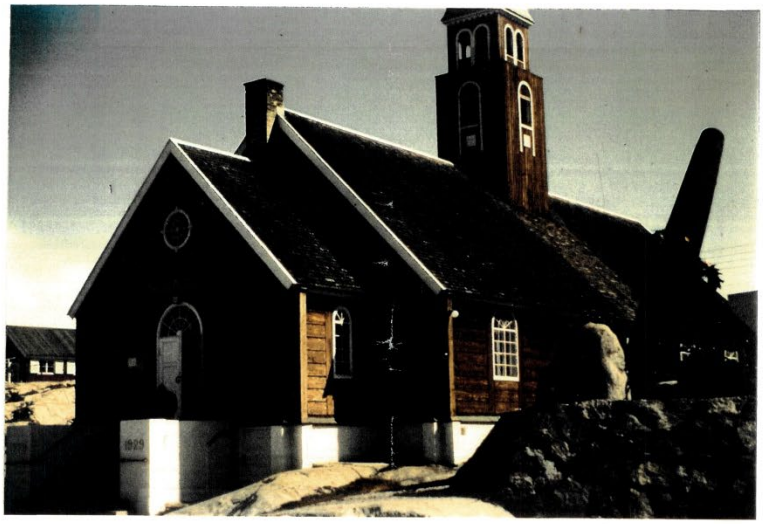
JUN 1982

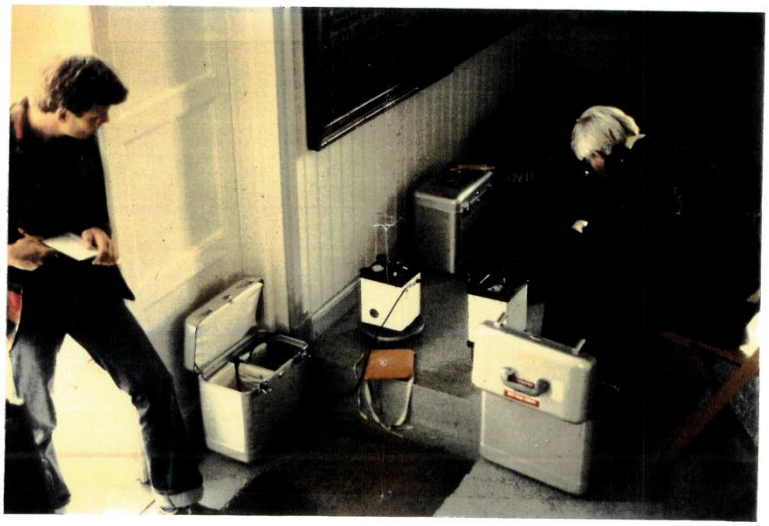


JUN 1982

JUN 1982

58201 Jakobshavn kirke





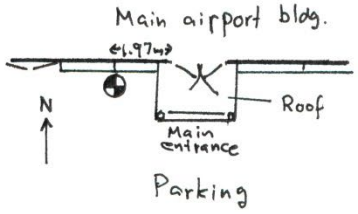
Kort- og Matrikelstyrelsen

TYNGDESTATION / GRAVITY STATION No. 58801

Stationsnavn / Station name		Land / Country
Ilulissat/Jakobshavn Airport		Greenland
Bredde / Latitude	**Længde / Longitude**	**Kote / Elevation**
69°13.61'N	51°05.59'W	29.1 m
Koordinat reference / Position reference		**Kotering / Elevation reference**
GPS		Engineering plan
Tyngdeværdi / Gravity value (mGal)	**Datum**	**Beregnet / Adjustment date**
982 486.929	Absolute	1988
982 486.97	IGSN71	do
Etableringsform / Monumentation		**Andet nr. / Other station no.**
Bronce plate mounted on foundation to airport bldg.		IfE 8801

Beskrivelse / Description — **Beskrevet / Description year:** 1988/91

2 m left of the main entrance to Ilulissat airport. On pavement, approx. 50 cm in front of the bronce plate.
Level of pavement 8.5 cm below plate.

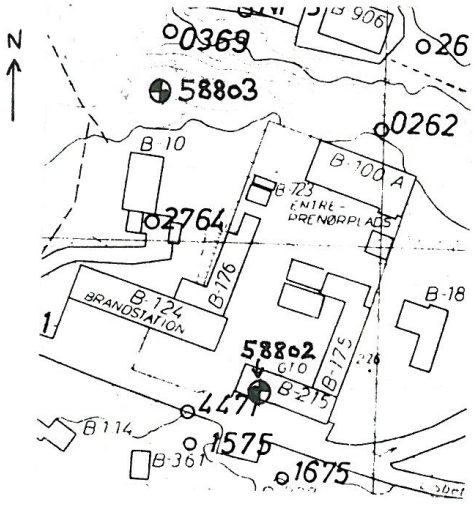


This description was compiled by (with date) RF feb 92

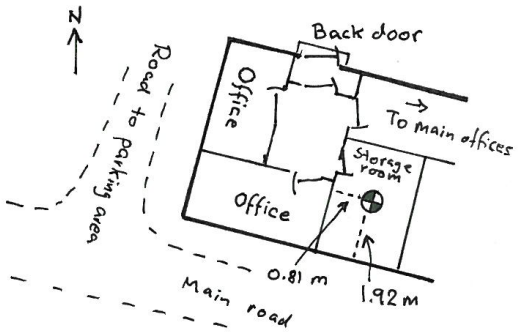
Kort- og Matrikelstyrelsen

TYNGDESTATION / GRAVITY STATION No. 58802

Stationsnavn / Station name		Land / Country
Ilulissat/Jakobshavn Absolute		Greenland
Bredde / Latitude	**Længde / Longitude**	**Kote / Elevation**
69°13.23'N	51°06.05'W	26.71 m
Koordinat reference / Position reference		**Kotering / Elevation reference**
Detailed GTO city map		Levelling
Tyngdeværdi / Gravity value (mGal)	**Datum**	**Beregnet / Adjustment date**
982 483.397	Absolute	1988
Etableringsform / Monumentation		**Andet nr. / Other station no.**
Bronce plug		IfE 1082
Beskrivelse / Description		**Beskrevet / Description year:**
		1988



Station in storage room in basement of GTO (later NUNATEK) main office, bldg. B-215. On concrete floor, 192 cm from S side of room, 81 cm from W side of room.



This description was compiled by (with date) RF feb 1991

Kort- og Matrikelstyrelsen

TYNGDESTATION / GRAVITY STATION No. 58803

Stationsnavn / Station name		Land / Country
Ilulissat/Jakobshavn absolute backup		Greenland
Bredde / Latitude	**Længde / Longitude**	**Kote / Elevation**
69°13.23'N	51°06.05'W	19.32 m
Koordinat reference / Position reference		**Kotering / Elevation reference**
GTO city map		Levelling
Tyngdeværdi / Gravity value (mGal)	**Datum**	**Beregnet / Adjustment date**
982 484. 910	Absolute	1988
Etableringsform / Monumentation		**Andet nr. / Other station no.**
GI bronce plate marked "tyngde"		IfE 8803

Beskrivelse / Description — **Beskrevet / Description year:** 1988/1991

On concrete pillar approx. 12 m N of old red building. Pillar measures 156 x 156 cm, gravity station in NW corner. Pillar is foundation of old antenna mast. See decription of absolute station 58802.

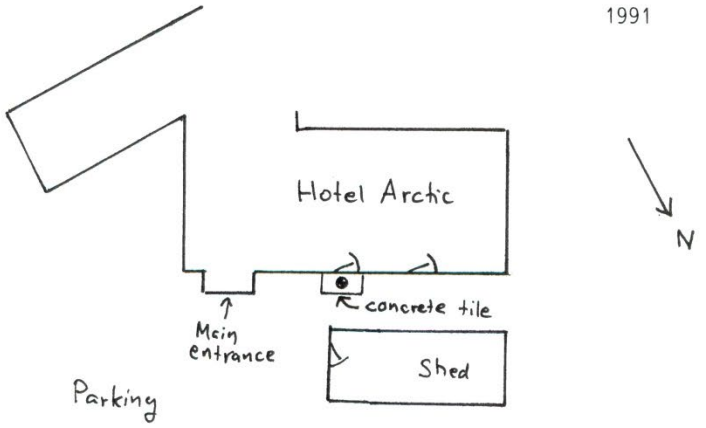
This description was compiled by (with date) RF feb 1992

Kort- og Matrikelstyrelsen

TYNGDESTATION / GRAVITY STATION No. 59101

Stationsnavn / Station name		Land / Country
Ilulissat / Jakobshavn Hotel Arctic		Greenland
Bredde / Latitude	**Længde / Longitude**	**Kote / Elevation**
69°13.61'N	51°05.59'W	
Koordinat reference / Position reference		**Kotering / Elevation reference**
GPS		
Tyngdeværdi / Gravity value (mGal)	**Datum**	**Beregnet / Adjustment date**
982 481.80	IGSN71	Oct. 91
Etableringsform / Monumentation		**Andet nr. / Other station no.**
None		

Beskrivelse / Description — **Beskrevet / Description year:** 1991



Ilulissat. Hotel Arctic. On concrete tile in front of door to kitchen approx. 12 m to the right of the main entrance.

This description was compiled by (with date) RF 92