

## Iceberg Formation

Icebergs are classified according to their size and shape. The life cycle of a typical iceberg found in the North Atlantic today might look something like this:

TIME LINE	ICEBERG DEVELOPMENT
1,000 B.C.	Snow/Firn
950 B.C.	Ice/Glacier
--	Glacier movement
1998 A.D.	Calving
2001 A.D.	Iceberg melt

Snow falls on the ice cap of Greenland. Over the course of several months it changes into firn, which is basically a granular snow. Several decades later it is compressed into very dense ice by the weight of the firn and snow that has accumulated on top of it. Driven by the enormous mass of the ice cap above, the ice flows seaward through openings between the mountains that occupy Greenland's coastal areas. This flowing ice is known as a glacier. Some glaciers move up to 20 meters a day.

At the glacier's terminus, or end, huge slabs of ice break free of the glacier, a process that is called calving. By the time these mountains of ice enter the ocean they have seen nearly 3,000 years pass. Once waterborne, icebergs are driven primarily by the ocean currents. This occurs because 7/8 of an iceberg's mass is below the waterline. Therefore, the currents have greater surface area to push against compared to the area affected by the winds.

The trip from the glacial terminus to the North Atlantic shipping lanes is long and complicated. Depending on where the iceberg is calved from and the oceanographic conditions, it can take up to three years to complete. In fact, most icebergs never make it as far as the shipping lanes because once an iceberg enters the ocean, its destruction has begun. One estimate is that of the 15,000 to 30,000 icebergs produced annually by the glaciers of Greenland only one percent (150 to 300) ever make it to the North Atlantic shipping lanes. When an iceberg does happen to reach the relatively warm waters southeast of Newfoundland, its long and traveled life quickly comes to an end.



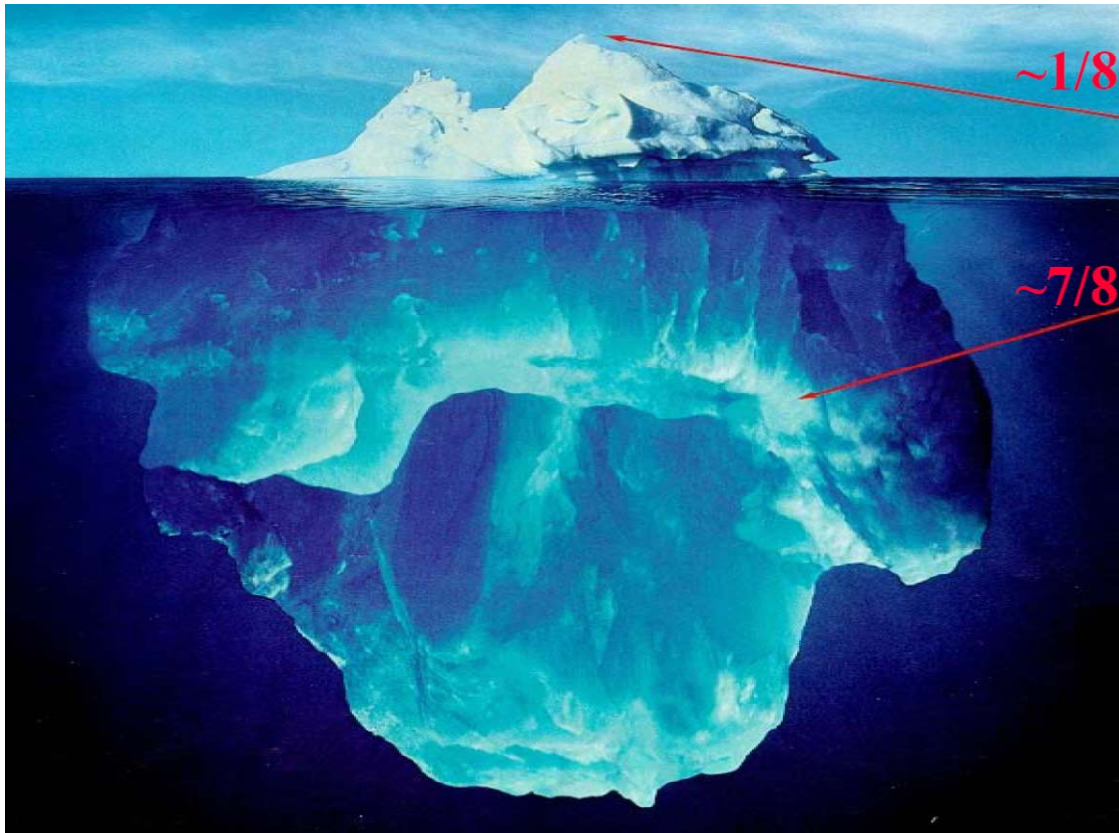
NUMEROUS ICEBERGS OFF BAFFIN ISLAND.

## **Calving**

Icebergs are created when pieces of ice break free from a glacier or an ice shelf and begin to float in the ocean. This process is called calving. The details of calving process are not well understood, but several factors are thought to play a major role. These include complicated glacial dynamics such as glacial surges, the rise and fall of the ocean tides and ocean waves that project from storms or tsunamis.

## Iceberg Mass

About  $7/8$  of the mass of an iceberg is below the surface. This figure is approximate because there can be differences in the density of the ice that makes up the iceberg, sea water density, the amount of rocks and sediment on the iceberg, and the amount of snow on the iceberg. Keep in mind we are talking about an iceberg's mass, not simply the height above the surface and the depth of the iceberg's keel. Determining how deep an iceberg extends below the surface is not a simple case of measuring its height and multiplying by 7 to obtain its depth. See the table in the Iceberg Shape section for estimates of the approximate height to draft ratio for the various iceberg shapes.



Artistic interpretation of the dimensions of an iceberg underwater.

## Iceberg Size

The range of iceberg sizes depends on the characteristics of the glacier or ice shelf from which the iceberg is calved. The massive ice shelves of the Antarctic can calve icebergs the size of a Caribbean island. The icebergs in the North Atlantic are much smaller. In the North Atlantic an iceberg more than a kilometer in length is unusual, while in the Antarctic icebergs greater than 10 km in length are common.

This table shows the size categories for the icebergs found in the North Atlantic Ocean. Strictly speaking, to be classified as an iceberg the mass of ice must be greater than 15 m long or 5 m in height. Smaller pieces of freshwater ice are called growlers or bergy bits.

<b>North Atlantic</b>			
<b>Description</b>	<b>Height (m)</b>	<b>Length (m)</b>	<b>Scale (Above Water)</b>
Growler	< 1	< 5	small sedan
Bergy Bit	1 to < 5	5 to < 15	small, one story cottage
Small Iceberg	5 to 15	15 to 60	small office building
Medium Iceberg	16 to 45	61 to 120	mid-size business district hotel
Large Iceberg	46 to 76	121 to 200	New Orleans Superdome
Very Large Iceberg	> 75	> 200	large hotel/convention center complex

There is no generally accepted set of size categories for other areas, but the following categories, used by the Australian Antarctic Program, reflects the fact that in the Antarctic there are more icebergs in the large end of the range.



<b>Australian Antarctic Program</b>	
<b>Category</b>	<b>Length (m)</b>
1	25 to 100
2	100 to 200
3	200 to 400
4	400 to 800
5	800 to 1600
6	1600 to 3200
7	> 3200






## Iceberg Shape

Icebergs come in a wide variety of shapes, but they can be placed into several categories as shown in the below table, which is based on:

Environment Canada, 2005. *Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE)*. Revised Ninth Edition. Ottawa: Canadian Ice Service, Meteorological Service of Canada, Environment Canada.

<http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=4FF82CBD-1>

<b>Shape</b>	<b>Photograph</b>	<b>Approximate height to draft ratio</b>
<p><b>Tabular</b></p> <p>An iceberg with steep sides and flat top having a length-to-height ratio greater than 5:1. Many show horizontal banding.</p>		<p>1:5</p>
<p><b>Non-Tabular</b></p> <p>Describes all icebergs that are not tabular shaped as described above. This category is further subdivided to include the specific shapes described below. If no other description applies, the iceberg is simply referred to as a non-tabular.</p>		<p>1:5</p>

Shape	Photograph	Approximate height to draft ratio
<p><b>Domed</b></p> <p>An iceberg with a smooth, rounded top.</p>		<p>1:4</p>
<p><b>Pinnacle</b></p> <p>An iceberg with one or more spires.</p>		<p>1:2</p>
<p><b>Wedge</b></p> <p>An iceberg having a steep vertical side on one end and sloping on the other.</p>		<p>1:5</p>
<p><b>Drydock</b></p> <p>An iceberg that has eroded so a slot or channel is formed.</p>		<p>1:1</p>
<p><b>Blocky</b></p> <p>An iceberg with a flat top and steep</p>		<p>1:5</p>



<b>Shape</b>	<b>Photograph</b>	<b>Approximate height to draft ratio</b>
vertical sides. Blocky icebergs have a shorter length-to-height ratio than tabular icebergs.		

## Largest IIP Iceberg

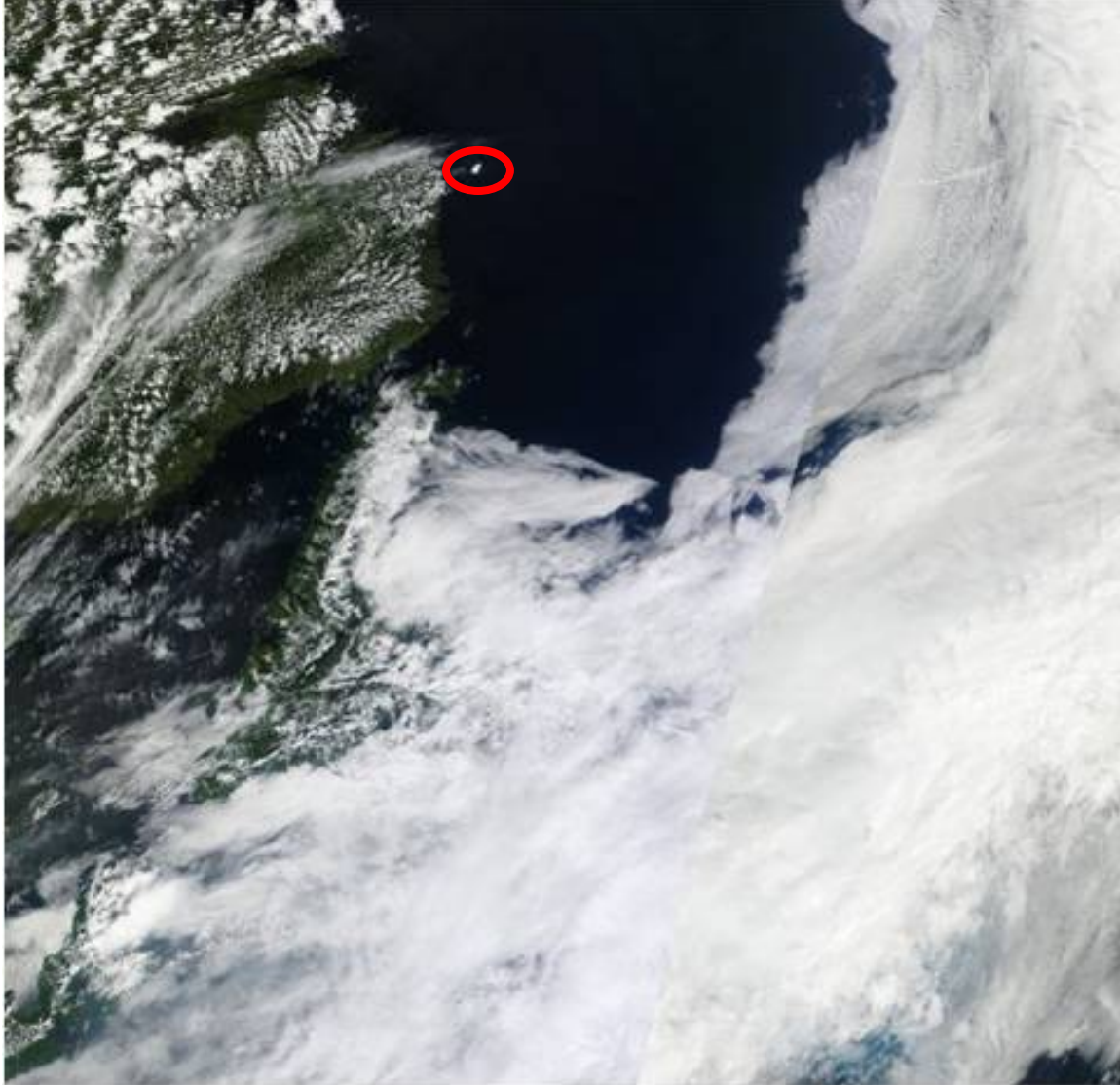
IIP doesn't keep official records of iceberg sizes but there is documentation for several massive ice islands and icebergs in the western North Atlantic (including Baffin Bay and Nares Strait, which connects it to the Arctic Ocean).

Since 1900 there have been four icebergs with lengths greater than 10 km. WH-5, an ice island calved from the Ward Hunt Ice Shelf in the winter of 1961-1962, was approximately 20 km long when it entered Nares Strait. Earlier in the century, two icebergs with lengths greater than 10 km were seen, one in 1928 (12 km) and the other in 1934 (12 km).

In August 2010 the Petermann Glacier, which is in northwest Greenland, calved an enormous iceberg that was approximately 22 km in length when it first broke free. In early September, as it entered Nares Strait, it broke into two pieces. The larger had an area of 160 km<sup>2</sup>. Modern satellite-borne sensors have made it possible to take precise measurements and track the subsequent movements of the major pieces.



Photo of a fragment of the Petermann ice island. CGDX denotes the Canadian Coast Guard Cutter Des Groseilliers, 98 meters (~ 322 feet) in length. Photo Courtesy of Canadian Ice Service.



Satellite imagery of the Petermann Ice Island. Photo Courtesy of MODIS.

The Canadian Ice Service has extensively documented the calving and subsequent movement of the Petermann Ice Islands at: <http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=D32C361E-1&wsdoc=082CD667-6A9B-4205-AE25-A12B00D4E32B>

The tallest known iceberg in the North Atlantic was 550 ft (168 m) high, extending out of the water to almost the height of the Washington Monument. This iceberg was sighted in Melville Bay, Greenland from the ice breaker *USCGC Eastwind* by CDR Robertson Dinsmore in March 1957 in approximate position 75N, 67-30W.



Tallest iceberg sighted by the IIP. Picture taken in March of 1957 from the USCGC *Eastwind*.