Russian Arctic 2018. #2. P. 56.

DOI: 10.24411/2658-4255-2018-00018

ICE ISLANDS IN THE ARCTIC

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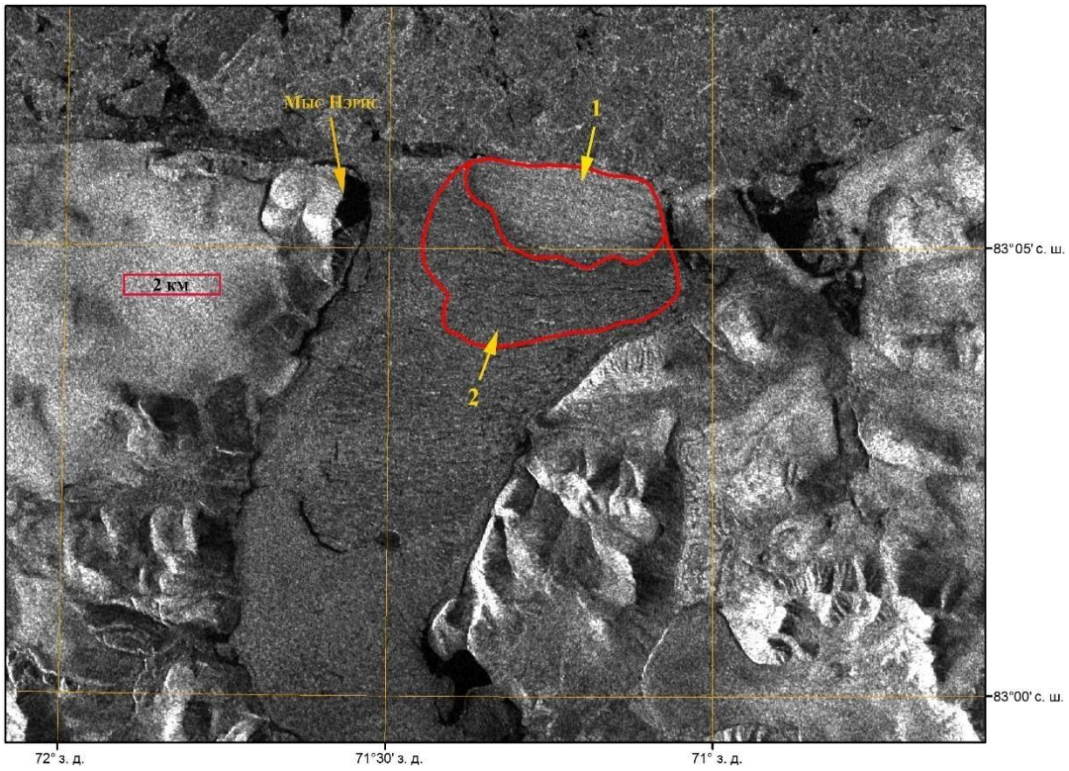
Information on the current condition of the Arctic ice shelf is briefly provided in the paper. Data about drift of one of the largest ice island are provided. It is concluded that such kind of ice formations are appropriate for organization of the drifting polar station “North Pole”.

Key words: Arctic, ice island, Markham, ice shelf, drifting station «North Pole»

In 1907 the Arctic explorer Robert Peary traveled by dogsleds in northern Ellesmere Island and described its ‘glacial fringe’ along the northern coast of the island. Modern glaciologists have determined that this ice shelf formed about 4500 years ago and, in time of Peary’s expedition, was likely a continuous ice shelf covering approximately 8900 km^2.By the 1950s this ice shelf had mostly disintegrated.

By July of 2008, the former massive ice fringe along the northern coast of Ellesmere Island had diminished to five separated ice shelves: Serson, Petersen, Milne, Ward Hunt, and Markham. Ayles Ice Shelf was completely lost in 2005. These five ice shelves remained the last ice shelves in Canada.

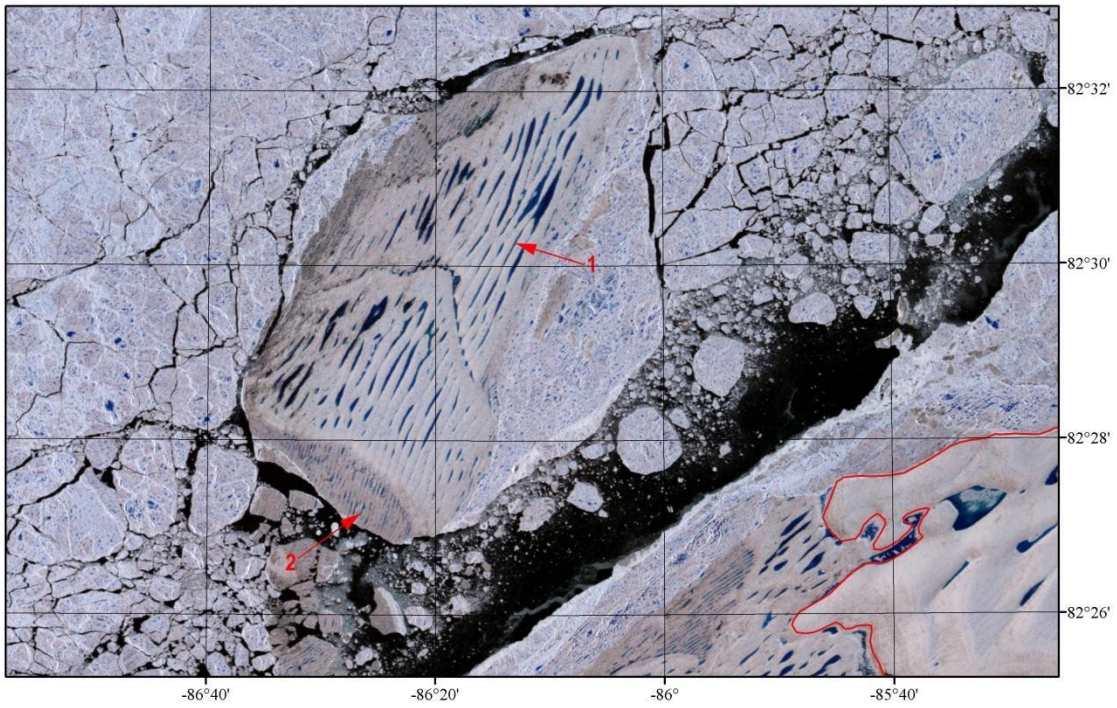
On July 22, 2008, a new period of ice shelves disintegration began and, by the end of August, the surface area of ice shelves had decreased by 214 km^2.Ward Hunt Ice Shelf lost a total of 42 km^2, Serson Ice Shelf lost 122 km^2, reducing in area by 60%. Markham Ice Shelf (Fig.1), covering a total area of 50 km^2, completely collapsed.



1 – elevated part of the ice shelf, subsequently the core of the drifting ice island; 2 – low-lying part of the ice shelf

Figure 1 – Radar image of Markham Ice Shelf before Markham ice island calving, taking by RADARSAT-1 (15 m resolution) on September 11, 2002.

During the ice shelves disintegration, a vast amount of ice islands was formed, each of them was ‘a large piece of floating ice protruding about 5 m above sea level, which has broken away from an Arctic ice shelf. Such islands have thickness of 30-50 m and an area of from a few thousand square meters to 500 km^2 or more. They are usually characterized by a regular undulating surface giving ribbed appearance from the air’ [1]. The first of the group of ice islands, Ayles Ice Island (Figure 2), calved in August, 2005 [2]. With a total area of 66 km^2, it has been the largest ice island for the last 40 years. BBC (British Broadcasting Corporation) organized an expedition, one of its objectives being to measure the thickness of the Ayles Ice Island. The average thickness was significant and varied from 42 to 45 meters.

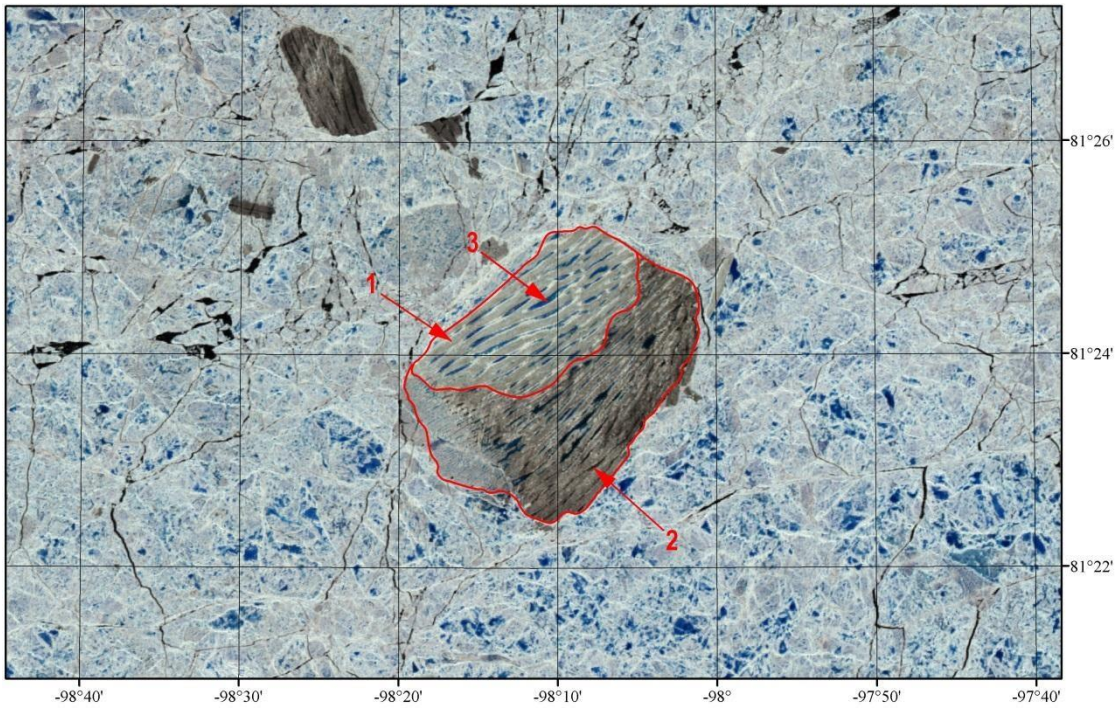


1 – elevated part of the ice island, subsequently the core of the drifting ice island; 2 – low-lying part of the ice shelf

Figure 2 – Multi-channel image of the future Ayles Ice Island captured on July 19, 2007 by ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) aboard the Terra satellite (resolution 15m).

The main group of drifting ice islands particularly notable by their quantity, varied by size and surface type, calved in July-August, 2008. After the ice islands broke up, they drifted along their general trajectory toward the channels of the Canadian Arctic Archipelago (CAA), and by the end of September 2009, most of the islands ended up drifting into the channels. A few of these islands, some of them of considerable size, remained within the slow-moving ice drift zone of the Arctic basin in the immediate vicinity of these channels. Presumably, some of these ice islands could pass by the channels and reach the Beaufort Sea.

Markham Ice Island, formed in August 10, 2008 as a result of total collapsing of the Markham ice shelf into several ice islands, was another large ice island with length of 5.1 km and width of 3.6 km. Markham Ice Island was formed from the front side of the homonymous ice shelf (Figure 1) and consisted, similarly to the Ayles Ice Island, of two presumably unequal in thickness parts. The main part of the island (its core) was probably elevated and sized 2.0 x 3.4 km in its medium part (Figure 3). The rest of the island was lowland covered by sea algae producing strong backscatter on radar images.



1 – elevated part of the ice island (the core); 2 – low-lying part of the ice island; 3 – fresh meltwater lakes on feet of the ice waves.

Figure 3 – Multispectral image of Markham Ice Island captured on July 16, 2009 by ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) aboard the Terra satellite (resolution 15m).

Markham Ice Island had undulating surface (Fig.3) [3]. The wave-like pattern of the ice island had a length scale of 160-230 m on the elevated part and 80-120 m on the lower part. According to several researches, wavelengths on the ice island's undulated surface were in direct proportion to the thickness of the ice island [4, 5, 6]. Comparisons of known thickness of the Ayles Ice Island and ice wavelengths on the surface both of the Ayles and Markham Ice Islands made it possible to calculate the approximate thickness of the Markham Ice Island. The elevated part of this island was probably 30-34 m thick, and the low part was 12-15 m thick.

During summer periods, meltwater lakes were formed on troughs on the surface of the Markham Ice Island. With lengths fluctuating from 200 to 2000 meters and widths of 15-100 meters (Fig.3), these lakes could serve as runways during winter periods. Preliminary analysis of ASTER data as of July 16, 2009 revealed potential sites for establishing a drifting research station on the elevated part of the island.

Recurrent observations of Markham Ice Island indicated the absence of significant changes from high dynamic stress load while drifting through the Arctic basin. The only exception is the lower part of the island that seems to have undergone slow partial destruction, according to the available data. This could

have been caused by the presence of sea algae on the surface of the low part of the ice island mentioned earlier. Sea algae undoubtedly had a slow destructive impact on ice strength. Data analysis suggests that the elevated part of Markham Ice Island was free from sea algae, did not suffer from the ensuing decay, and represented itself as a sufficiently strong core.

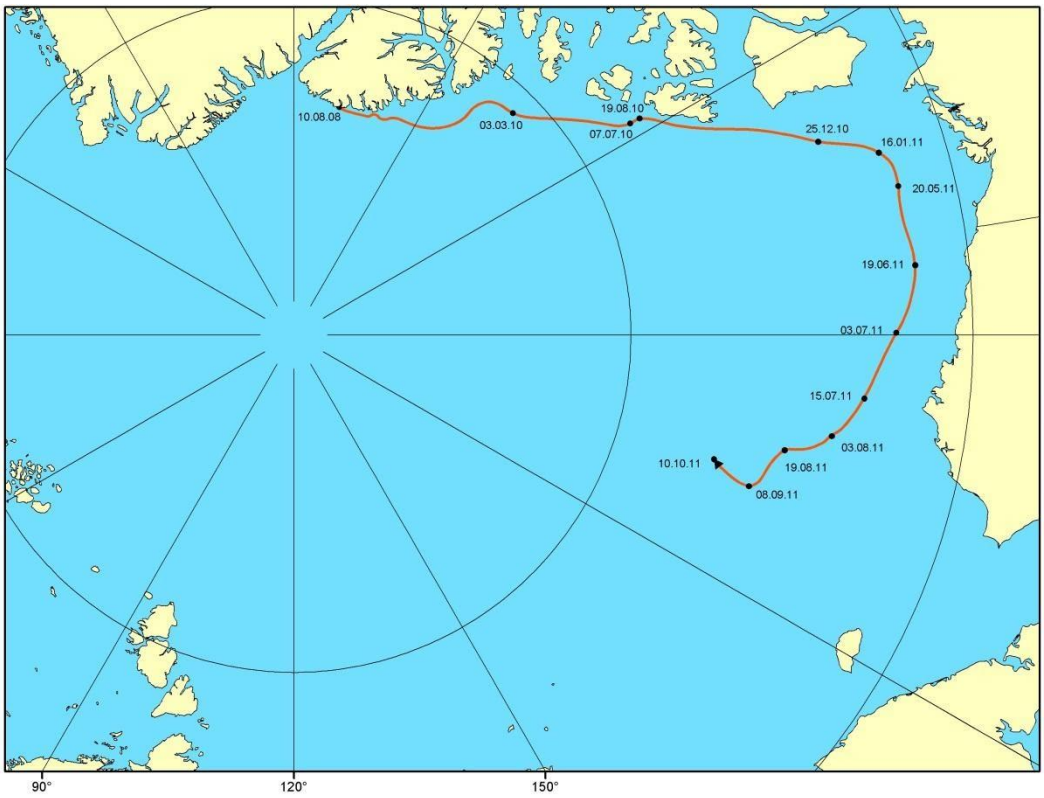


Figure 4 – Drift track of Markham Ice Island for the period from August 10, 2008 to October 10, 2011.

During the initial period of less than 2 years, Markham Ice Island had moved about 1000 km. Ice island drift speeds were insignificant during the first– the most extended – period, excepting just a few days (Fig. 4). Thus, from August 11 to August 12, 2008, in the immediate vicinity of Ellesmere Island, the Markham ice island moved at a record rate of 41 km d $^{-1}$. At the beginning of 2010, after leaving the slow-moving ice drift zone at the entrance to the CAA channels, the ice island's drift speed increased significantly, reaching 5.8 km d $^{-1}$ in the last days from July 1 to July 7. At the beginning of 2011, Markham Ice Island passed through the Canadian channels, which are the way of significant pack-ice outflow from the Arctic Basin, to the Beaufort Sea and would be able to serve as a new ice research station [7].

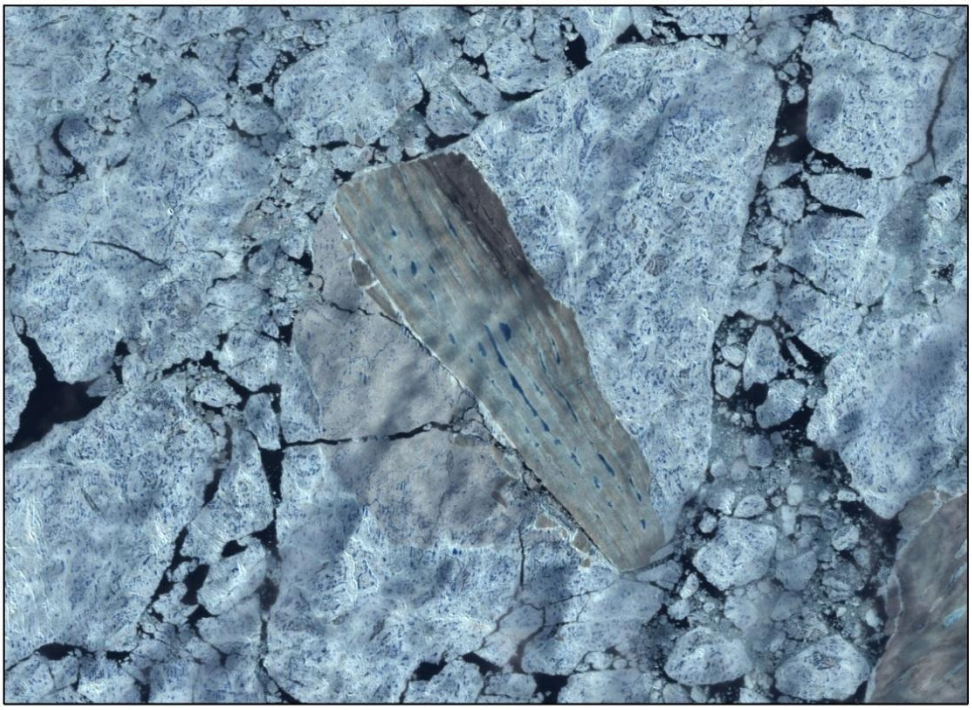


Figure 5 – Multispectral image of ice island near the CAA coastline, received on August 11, 2016 by Sentenel-2A (resolution 10 m).

At present, one more ice island of significant scale (1.4 x 5.3 km) drifts in the Canadian Arctic (Fig.5). It is expected to enter the Beaufort Sea at the end of the summer of 2019. If its current size and condition remain the same, this ice island could become a palmary ice platform for long-term scientific research in the Arctic. An example from the history of Russian arctic research, the 'North Pole-22' research station was established on a similar ice island and served as a research platform for more than 7 years.

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