The Cape York Meteorite

Making an Impact on Greenland

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Introduction

On the northwestern coast of Greenland, the Iron Age began hundreds of years before iron was brought to southern Greenland by Icelandic farmers (Wilken, 2015). Meteoric iron has been present in the region since at least 1000 CE, when a group of about 300 Inuit settled Melville Bay, which is bounded in the north by Cape York (Buchwald, 1975). These meteorite blocks attracted Inuit from across the Arctic, and tools made with fragments harvested from the Cape York meteorite allowed Arctic Inuit to progress from the Stone Age to the Iron Age (Huntington, 2002). Had there been no meteoric iron present in Melville Bay, the area may have never been successfully settled at all.

Inuit told the explorer Robert Peary in the late 1800s that legend was that the three major meteorite blocks were an Inuit woman who was thrown from the sky along with her dog and tent by the evil spirit Tornarsuk. It is possible this is true, but it is more likely that the Inuit were humoring Peary with the story he expected to hear – that they believed the rocks were meteoric in origin. As neither John Ross nor any other polar explorer ever recorded hearing a similar story, it is probable that the Inuit believed the iron blocks were simply natural deposits (Buchwald, 1975).

For hundreds of years, these meteorite blocks were an indispensable resource for the small group of Inuit living in this barren part of the world. As explorers from abroad began to make their way north seeking a route to the pole in the 1800s, the Inuit gained access to resources through trade but lost a piece of their history. Most of the Cape York meteorite specimens are no longer in Greenland. Robert Peary took the Ahnighito (Tent), Woman, and

Dog specimens, all three of which are now on display at the American Museum of Natural History, and Knud Rasmussen took Savik I to Copenhagen in 1925 (Wilken, 2015).

Background

Chemistry and Origins

Meteorites fall into three main categories. Stone meteorites are primarily silicic, iron meteorites comprise more than 5% nickel and contain other trace metals, and stony-iron meteorites have characteristics of both stone and iron meteorites (Huntington, 2002). Cape York is an iron meteorite of chemical group IIIAB. It is a medium octahedrite with approximately 8% nickel content (The Permanent Commission on Meteorites of the International Geological Congress, 1963). The specimen displays the classic Widmanstätten pattern, a distinguishing feature of iron meteorites. This cross-hatched pattern is due to lamellae of kamacite and taenite, two types of iron-nickel alloy, intergrowing geometrically. The impactor experienced a molten stage on a parent body with a gravity field. This is indicated by the parallel orientation of magnetic minerals within the samples (Buchwald, 1975). Like all iron meteorites, the Cape York specimens are pieces of the metal core of an asteroid destroyed in a collision with another asteroid (Applet, et al., 2015).

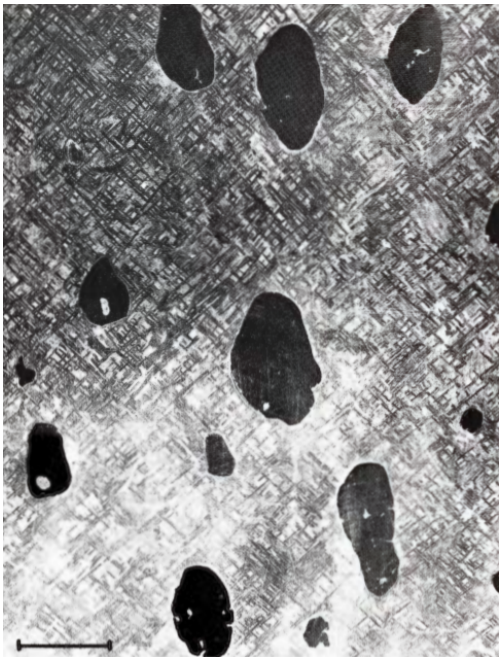

Figure 1. The Widmanstätten pattern visible in a thin section of the Cape York meteorite. Scale bar 50 mm. Image from Buchwald, 1975.

Impact and Specimens

The fall over northwest Greenland was described in 1975 as the largest meteorite shower recorded. The site of the fall is located about 50 km northeast of Cape York (Buchwald, 1975). The Cape York impactor is estimated to have originally been several meters wide. It broke up in the air over Innaanganeq (the Cape York Peninsula) in northwest Greenland (Wilken, 2015). The parent body of the Cape York meteorite blocks was 4.5 billion years old. The original meteorite was about 200 tons before it broke apart in the atmosphere (American Museum of Natural History, n.d.). 8 major specimens have been recorded with a total weight of over 58 tons. The impact is estimated to have occurred over 10,000 years ago. There was no evidence of impact under the Agpalilik specimen such as crushed rocks or cratering. Vagn F. Buchwald, who discovered Agpalilik, suggested that at the time of impact the region may have been glaciated, and the meteorites fell to rest at their present locations as the ice melted under them. The fragments were present before the Melville Bay region was settled around 1000 CE by a group Knud Rasmussen referred to in 1914 as the "Thule Eskimos." Inuit referred to the site at which the blocks Woman, Dog, and Tent were found as "Savisavik," derived from the work "savik," meaning "knife" or "iron" (Buchwald, 1975). They called the Woman block "Saviksoah," meaning "the great iron" (Rizzo, 2013).

The meteorite blocks differ in both shape and degree of exposure. Macroscopically, Dog is ellipsoidal, Savik I is triangular, and the larger Ahnighito (Tent), Woman, and Agpalilik are irregular and angular. All the specimens are covered with depressions from atmospheric flight and, especially on Savik I, corrosion from exposure to air. The way the impactor fractured may be due to existing fissures in the mass created during the episode which resulted in its ejection from its parent body (Buchwald, 1975). Tent is 3 meters long, 2 meters high, and 1.8 meters

thick (Rizzo, 2013). It is asymmetrical, with a long ridge along its top and a depression below it. This shape is a result of weathering; the part of the meteorite which was buried in soil was chemically weathered more quickly than the part exposed to air (Buchwald, 1975). The Tent specimen is so massive that the supports for its display at the American Museum of Natural History extend into the bedrock below the museum (American Museum of Natural History, n.d.). The Woman and Dog blocks appear to be the most heavily worked. Their surfaces have been entirely smoothed by centuries of hammering. Microscopically, minerals in the outer layers of these two masses have been overfolded as a result of plastic deformation from mining. It is possible that Woman and Dog were chosen as the primary meteorites blocks for mining because they are slightly more silicate-rich, and thus easier to work (Buchwald, 1975).

Figure 2. The Tent specimen on display at the American Museum of Natural History. Image from Huntington, 2002.

Figure 3. The Tent specimen in situ. Image from Huntington, 2002.

Use by Inuit

It was a 3-day walk from Cape York to Savisavik. Temporary buildings at the site were constructed from stone, providing shelter for workers (Iron From the Sky, 2014). Multiple of the former meteorite block locations are easily identifiable, surrounded by piles of broken basalt,

remnants of the stone tools used by generations of Inuit to quarry iron. The piles contain up to an estimated 20 metric tons of stones. These rocks range in size, weighing up to 40 kg. Larger stones were likely used as anvils, and smaller stones as hammer heads (Wilken, 2015). The 3-ton Woman and 400 kg Dog were the most heavily mined blocks, both showing physical evidence of mining on their surfaces. Dog was located 29 m downhill from the irregularly shape Woman and is potentially a detached piece of the larger block. The "head" of Woman was detached by miners and brought to a settlement called Peterawhik. Woman is surrounded by an 8-10 m diameter pile of hammer stones. It has been estimated that the pile contains up to 10,000 stones, each weighing 1-10 kg. Only a few hammer stones have been found circling Savik I, Ahnighito, and Dog. These piles accumulated over dozens of generations who traveled 50 km from Cape York to harvest iron. The basalt used to construct stone tools had to be brought to Savisavik from Cape York because the rocks at the fall site are gneissic, and not strong enough to mine with. In the most heavily mined specimens, the internal structure is deformed on the outer 3-5 mm due to continuous hammering (Buchwald, 1975).

Resources in northwest Greenland, such as wood, are scarce. Settlers made weapons from materials harvested from walrus, narwhal, and reindeer with sharp edges crafted from meteoric iron. Flakes of the meteorite could be cold-hammered into handles made from tusk, antler, or bone to craft knives, or larger fragments could be forged into tools and weapons by a blacksmith. Archaeologists have recovered knives made by the Dorset using handles carved from caribou bone and walrus tooth. An ax with a blade of meteoric iron was used by

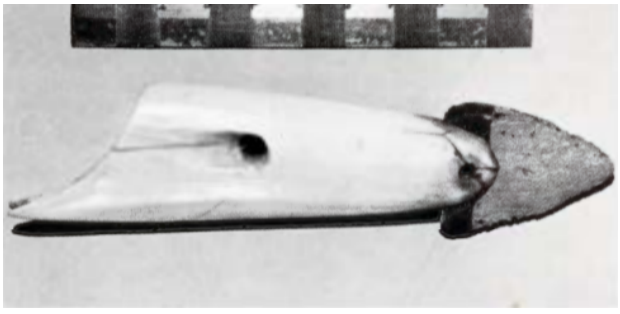

Figure 4. Walrus bone harpoon with point of meteoric iron. Image from Buchwald, 1975.

the Dorset or Thule (Buchwald, 1975). Access to iron tools made simplified life for the Arctic Inuit, making hunting and skinning animals significantly easier (Huntington, 2002).

Because its chemical composition is distinctive, archaeologists can trace fragments of the Cape York meteorite around the world to determine how far tools created with iron derived from it were traded. It is clear from chemical analysis that trade in the Arctic must have been widespread (Huntington, 2002). The Dorset people began using meteoric iron in the mid-8th century. A single fragment of the meteorite has been found in southern Greenland, in the area that was settled by the Norse. This was most likely brought to southern Greenland by traders from the north, as there is no evidence that Norsemen ever visited Cape York. Inuit took over and expanded the meteoric iron trade upon their arrival in the 12th century. Artifacts containing Cape York iron have been found across Canada, up to half the distance from Greenland to Alaska (Wilken, 2015). Other iron tools eventually made their way to Cape York via trade, making chemical analysis necessary to determine which tools were local and meteoric in origin and which were brought to the area by traders from abroad (Iron From the Sky, 2014).

Discovery by Outsiders

Early polar explorers were surprised, upon encountering Cape York residents, that they used iron-tipped weapons with no discernible access to the metal from either trade or to mining and smelting (Iron From the Sky, 2014). In 1818 Captain John Ross met the Inuit living in Melville Bay, a group he described as "Arctic Highlanders." John Ross was the first non-Inuit to become aware of the presence of the meteorites. During Ross's unsuccessful expedition to locate the Northwest Passage he was traveling with an Inuit, Sakaeus, from southern Greenland. Ross wrote that the "highlanders" believed they were the only people on Earth, although the fact that

Sakaeus was able to communicate with them indicates that people living in the southern and northern areas at some point (Huntington, 2002). Sakaeus initially had some difficulty communicating with the northerners. Centuries without contact between north and south Greenland led to cultural and dialect differences (Applet, et al., 2015). Using Sakaeus as an interpreter, Ross asked the Northern Greenland Inuit where they obtained the iron they used in their tools. Sakaeus told Ross that the Inuit said the metal came from a faraway "iron mountain." Ross correctly assumed that they were really talking about meteorites. The Inuit traded some of their metal-tipped tools to Ross but did not share the location of the "mountain" with him, as they wished to protect their only source of iron from outsiders (Huntington, 2002). Ross brought these tools back to England, donating some to the British Museum. The iron was analyzed years later and determined to meteoritic, at greater than 3% in Ni content (Buchwald, 1975). Though Ross never saw the Savisavik site himself, his expedition report, which contained references to artifacts containing meteoric iron, would later inspire Robert Peary (Meier, 2013).

Figure 5. Tools with metal cutting edges traded to Captain John Ross by Arctic Inuit in 1818. Image from Huntington, 2002.

The Savisavik site was described to arctic explorer I. I. Hayes during an expedition in 1861, when he was given fragments of the meteorite by Polar Eskimos. The area is devoid of smaller meteorite fragments, which would have fallen along with the larger blocks that have been found in situ. Presumably, these were gathered and brought back to Cape York soon after the site was discovered. This assumption is supported by archaeological digs of ancient

settlements, which have yielded small blocks of the meteorite. A 1.6 kg block called Akpohon was found in 1914 on Ellesmere Island in Nunavut, over 500 km northwest of Cape York. Fragments were also found by Hayes 400 km from Savisavik, near Etah (Buchwald, 1975).

Peary's "Strange Cargo"

In addition to his mission to be the first man to reach the North Pole, Peary mapped parts of northern Greenland and wrote about the Inuit way of life. Having failed his 1894 goal of setting the record for furthest distance travelled north, Peary sought to salvage the mission in another way (Meier, 2013).

For hundreds of years the Arctic Inuit were heavily reliant on the Cape York meteorite fragments. Understandably, this made them reluctant to share information about the iron with outsiders (Huntington, 2002). By the late 1800s, Cape York had become less isolated as a result of the steady stream of polar explorers passing through, who also provided a new and relatively easy source of iron through trade. This may be a reason that Peary was able to convince Inuit to show him the site of the meteorites, while they refused to share its location with Ross decades earlier (Rizzo, 2013).

Peary traded extensively with the Inuit, and this relationship was mutually beneficial. Over several years, Peary was able to gain some trust with the Inuit. In his notes, Peary describes the Inuit as "brown little wizards … much like children and should be treated as such." He wrote that their "feeling toward me is a blending of gratitude and confidence." While he saw himself as their benefactor, Peary was not seen by all Inuit in a positive light. He used their dogs to pull his sledges and relied on Inuit for labor. According to one Inuit, "his name up here (was) hated for his cruelty" (Huntington, 2002).

In 1894, Peary was given a sledge tour of the Cape York area by an Inuit befriended by him after the commencement of his 1891 expedition to the north. Peary promised the Inuit man a gun in exchange for showing him the location of the meteorite specimens (Huntington, 2002). The Inuit showed him the meteorite blocks Woman, Dog, and Tent (Buchwald, 1975). Peary may have used the fact that the Inuit had alternate access to trade to justify taking meteorites that had previously been their only source of iron, although this is unknown. It is known, however, that Peary never asked permission from the Inuit before taking them (Meier, 2013).

In 1895 Peary and his men began work bringing the meteorites to America aboard his schooner, Kite (Buchwald, 1975). They were able to bring both Woman and Dog back to New York in the same year, but Tent was too large (Rizzo, 2013). Peary first brought Woman to America and returned later to retrieve Dog. The meteorites were transported to Peary's ship on ice floes. At one point, the ice broke under Woman and the specimen was almost lost (Meier, 2013).

The island on which Tent was found is surrounded by a bay which only thaws for a few weeks a year. Peary's first attempt at recovering the meteorite failed when his schooner began to freeze into the ice. Peary called the Tent specimen "Ahnighito," the middle name of his daughter Marie, who was born in Greenland in 1893 (Meier, 2013). Peary would later write in his book *Northward Over the "Great Ice,"* "had the matter been a subject of study for weeks by the celestial forge-master, I doubt that any shape could have been devised that would have been any more completely ill-suited for handling in any way, either rolling or sliding or lifting." He paid local Inuit to haul the specimens over the island to his boat. First a 60-ton jack was used to move the meteorite. After that broke, a 100-ton jack was used. The meteorites were rolled over the ice on wooden planks and then ropes and winches were used to lift the rocks over the side of the

boat. It took over a year to get the meteorite out of the ground and onto Peary's boat (Rizzo, 2013).

In 1897, the 31-ton Ahnighito was brought to New York aboard Hope, a larger schooner. Peary at first significantly overestimated Ahnighito to weigh 90 to 100 tons, although not without reason. Upon its arrival at the New York Naval Shipyard, Ahnighito's bulk broke a 50-ton floating crane. Peary had difficulty at first convincing others that these blocks were indeed extraterrestrial in origin. Responding to his detractors, Peary directed them to the distinctive Widmanstätten pattern, calling it "the celestial trademark." The meteorite remained in the Brooklyn Navy Yard until it was acquired by the American Museum of Natural History in 1904 (Buchwald, 1975).

Peary did not return to the United States with only the meteorites as cargo. Franz Boas, an anthropologist and assistant curator at the American Museum of Natural History, had requested that Peary bring him a living Inuk person to study (Meier, 2013). In addition to taking the three large meteorite blocks, Peary also returned to New York with a suite of Inuit artifacts. He took with him human Inuit remains, as well as a small group of Inuit people he intended for Boas to study for a year and then bring back to Cape York (Iron From the Sky, 2014). Along with Ahnighito, Peary brought six Inuit to America in 1897. The group included a man named Qisuk and his young son, Minik. Peary promised them that they would be returned to Greenland the following year, and that he would provide them with tools and homes. Only two of them would ever make it home alive (Meier, 2013).

Minik told the *San Francisco Examiner* years later, "At the start, Mr. Peary was kind enough to my people… But as soon as he was ready to start home his other work began. Before our eyes he packed up the bones of our dead friends and ancestors. To the women's crying and

the men's questioning he answered that he was taking our dead friends to a nice warm and pleasant land to bury them. Our sole supply of flint for lighting and iron for hunting and cooking implements was furnished by a huge meteorite. This Peary put aboard his steamer and took from my poor people, who needed it so much." About how Peary convinced Minik's father and several others to accompany him back to America, Minik said "Our people were afraid to let them go, but Peary promised them that they should have Natooka [an Inuit hunter] and my father back within a year, and that with them would come a great stock of guns and ammunition, and wood and metal and presents for the women and children." The *Boston Post* front page on September 27, 1887, read, "Explorer Peary brings a company of esquimaux with him to Boston." The *Boston Post* article read "Once on board, (the public's) first object was to get a view of the much-famed meteorite, and after that they gave all their attention to the six red-faced natives of the Arctic who made a laughable sight as they ran up and down the deck in the clothes the sailors had given them… Next spring they will go back to their home in Cape York" (Meier, 2013).

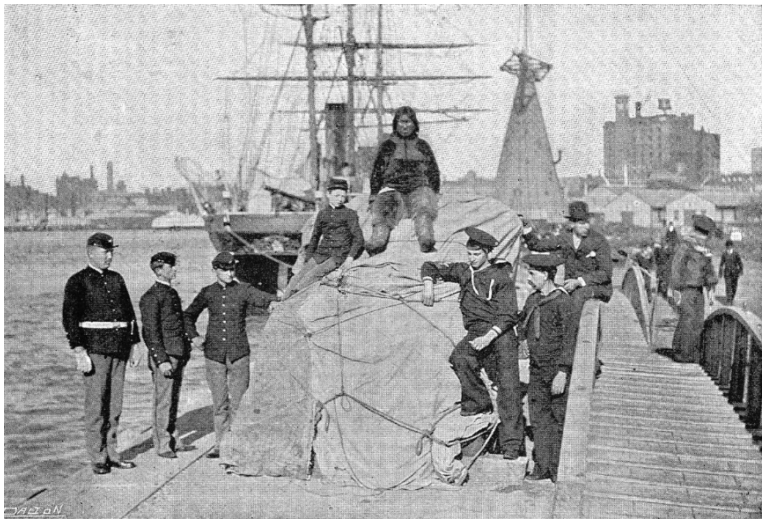

Figure 6. One of the Inuit brought to the United States by Robert Peary sitting atop the Tent specimen upon its arrival in America. Image from Meier, 2013.

The schooner, Hope, continued to New York after stopping in Boston. At the New York Navy Yard a 100-ton floating crane removed Tent from the schooner. The Inuit were taken to be studied by Boas and his assistant Alfred Kroeber at the Museum of Natural History. Minik would later describe their living quarters as "a damp cellar most unfavorable to people from the dry air

of the North." Having lived their entire lives in an isolated community on the northwest coast of Greenland, the Inuit had no immunity to American diseases. Making matters worse, a heat wave struck New York shortly after the Inuit's arrival. After only a few weeks in America, all the Inuit became ill. After eight months, all but two were dead of tuberculosis. One survivor returned to Greenland, and Minik, whose father was among the dead, was alone in America. The bodies were dissected by medical students, after which the bones were cleaned and placed in the museum's storage. A funeral was staged for Minik's father in Central Park. Minik would later learn that he had in fact watched a cloth-covered log be buried, and not his father. He would spend much of the rest of his life attempting to retrieve his father's bones from the museum so that he could bury them in Greenland (Meier, 2013).

William Wallace, the museum superintendent, adopted Minik with his wife after Minik was abandoned by Peary. Although his adoptive family was loving, Minik never overcame the deep sense of isolation of being the only one of his people in New York. After briefly enrolling in Manhattan College in 1909, Minik was able to convince the Peary Arctic Club to sponsor his trip back to Greenland. Peary had otherwise dropped all contact with Minik and had refused him passage to Greenland on his ship during his most recent expedition. Peary finally agreed to help send Minik back to Greenland only to avoid bad press overshadowing his successful return as the first man to reach the North Pole (Meier, 2013).

Minik attempted to resettle in Cape York, but although he was able to re-learn how to hunt and speak his own language, he began to miss city life. Seven years in 1916, Minik returned to New York and made one final attempt to retrieve his father's bones. Failing this and unable to secure a job in New York, he moved to New Hampshire and became a lumberjack, living and working on a friend's farm. Minik died of the Spanish flu in 1818 and was buried on his friend's

farm. His father's bones were returned to Greenland in 1993. The plaque on his grave is written in his language and reads "They have come home" (Meier, 2013)

Later Discoveries

In 1910 Knud Rasmussen began encouraging the Polar Eskimos to search for more meteorite fragments. This paid off soon after in 1913, when to 3.4-ton Savik I was found on a promontory 10 km east of Woman and Dog. The skirt of discarded hammer stones around Savik I indicates that its presence was known to previous generations, but then later forgotten. After a delay in the recovery of the specimen due to World War I, it was recovered in 1923-24 by Harry Nielsen. Then the manager of the Thule trading post, Nielsen used a total of 175 dogs and 14 sledges to pull Savik I across 25 km of sea ice to the open water. He was met by a ship waiting to sail the meteorite to Copenhagen, where it arrived in 1925. After reaching Copenhagen, 100 kg of slices were cut from the 3402 kg block, becoming the primary source of data for nearly every paper published regarding the Cape York meteorite for decades until the discovery of the Agpalilik specimen (Buchwald, 1975).

The Agpalilik specimen of the Cape York meteorite was the sixth to be scientifically described and the second largest recorded (The Permanent Commission on Meteorites of the International Geological Congress, 1963). Dr. Vagn F. Buchwald returned to the major 4 known sites (Woman, Dog, Ahnighito, and Savik I) in the summer of 1963 to determine their exact localities and to map the extent of the fall. While surveying the area he discovered to 20-ton Agpalilik partially covered by gneissic boulders (Buchwald, 1975). The locality, on the Agpalilik Peninsula 125 km southeast of Thule, was 6 km away from the landing site of both the Woman and Dog specimens (The Permanent Commission on Meteorites of the International Geological Congress, 1963). The meteorite was partially buried 500 m from the shore of Melville Bay.

Agpalilik's surface was undamaged by hammer marks and no basalt fragments surrounded it, indicating that its presence was never discovered by Inuit. Buchwald suggested that the block may have gone undiscovered for so long because it was covered by snow and ice nearly year-round. Before it was dug out Buchwald estimated the specimen to be approximately 15 tons. It was taken to Copenhagen in 1967 (Buchwald, 1975).

Legacy

The Cape York specimens have been a significant source of information on the class III A and B meteorite groups. Analysis of the Agpalilik specimen provided confirmation that meteorites of the IIIA group have been through a molten stage in their history. Class III meteorites are a relatively common group, and knowledge of the Cape York meteorite can be extrapolated to describe characteristics of the group. Cape York is chemically similar to other class III meteorites, although all meteorites vary somewhat in structure due to various episodes of shock and heating in space (Buchwald, 1975).

A large cut of Agpalilik is now on display at the Mineralogical Museum of Copenhagen (Buchwald, 1975). In 1909 the Arctic display at AMNH began, at Peary's direction, with "Eskimo Hall." Inuit mannequins were posed around campfires and tents crafting tools with meteoric iron fragments. Later, the Natural History Museum would distance itself from Peary as doubt spread over whether he ever actually reached the North Pole. Eskimo Hall was removed, replaced with the Frederick Phineas and Sandra Priest Rose Center for Earth and Space. Woman and Dog were moved from the American Museum of Natural History in 1935. The lobby of the Hayden Planetarium was built around them. In 1980 Tent was moved from the Arctic exhibit at AMNH to the Arthur Ross Hall of Meteorites, where it remains the centerpiece today

(Huntington, 2002). The only mention of Peary in the museum is on one of the plaques at the meteorite display, describing the process of his removal of the meteorites from Greenland. There is little indication of the darker history of their journey to America. The meteorite itself stands as the only monument to Minik, his father, and the four other Inuit taken by Peary from Cape York.

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