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Igor Krupnik, Michael A. Lang, and Scott E. Miller
Editors

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From Ballooning in the Arctic to 10,000-Foot Runways in Antarctica: Lessons from Historic Archaeology

Noel D. Broadbent

ABSTRACT. The author discusses three archaeological investigations of historic sites in the polar regions. The first site is that of the Solomon A. Andrée expedition camp on White Island, Svalbard. This fateful ballooning expedition to the North Pole in 1897 was the first experiment in polar aeronautics. Andrée and his colleagues gave their lives but opened the door to polar flight, the backbone of polar logistics today. The other site, East Base, on Stonington Island off the Antarctic Peninsula, served the1939–1941 U.S. Antarctic Service Expedition, under Admiral Richard Byrd, the first U.S. government–sponsored scientific and aerial mapping effort in Antarctica. In 1992, a team of archaeologists documented and secured the site that had been recently recognized as an historic monument by the Antarctic treaty nations. The third site is Marble Point on Victoria Land across from Ross Island and McMurdo Station. In conjunction with the IGY 1957–1958, a massive effort was put into laying out a 10,000-foot year-round runway and creating a fresh water reservoir and other base facilities. It was one of the premier locations for strategic aviation in Antarctica. The site was archaeologically surveyed and original engineering documentation from 1956–1957 offers superb baselines for studying permafrost, erosion, and human disturbances in the Antarctic environment. These types of sites are in situ monuments to human courage, ingenuity, and perseverance on a par with NASA's exploration of space. They require careful management and protection following the same principles as historic sites within the United States and in other nations.

INTRODUCTION

There is a seemingly limitless public interest in polar exploration. This fascination is one of the greatest resources we have for support of polar science: Public enthusiasm for polar history and exploration should be actively acknowledged in projects of these kinds. With volunteer help led by professional archaeologists on regular tour ships, site documentation and cleanup efforts could be carried out on a scale that would otherwise be impossible to achieve.

This paper is about international polar history and heritage along with science and technology in context. We are now embarked on the Fourth International Polar Year. In addition to projects in the natural and physical sciences, focusing especially on issues of global change, there are a number of themes in anthropology and archaeology, and new historic archaeology projects are being initiated at both poles.

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The three archaeological studies presented here span 60 years of aviation history from before the period of fixed-wing aircraft to the International Geophysical Year in 1957–1958. They also relate to competing national interests in the polar regions including Nordic rivalries, U.S. and German conflicts over Antarctic territories during World War II, and Cold War strategic thought in the southern hemisphere.

Historic archaeology is based on the theories and methods of traditional archaeology but applies these to historic periods (South, 1977; Orser, 2004; Hall and Silliman, 2006). One great advantage of historic archaeology over prehistoric archaeology is that it can be matched with written sources that may reveal, among other things, the motives behind various endeavors and the details of planning and consequent successes and failures. However, written history tends also to focus on the larger picture of given events and can be biased by political, social, or other concerns of the times. Physical evidence and archaeological analysis can be used not only to test hypotheses about historical events but also, of equal importance, to provide information about the daily lives of individuals that rarely make it into historical accounts.

Global warming, one of the great scientific concerns of today regarding polar ecosystems, is having profound impacts on archaeological sites. These sites are subject to increasingly severe weathering and erosion damage. Warmer conditions have also made them more accessible to tourism, as well as to looting. Documentation of these sites is urgently needed. This is exemplified by the Andrée site in Svalbard, Norway. While such efforts have intrinsic value in and of themselves, the importance of these investigations extends beyond that, inasmuch as the sites themselves can provide baselines for measuring the effects of climate change over time. This is the case of the two Antarctic sites, East Base and Marble Point.

THREE CASE STUDIES

The first study was an investigation of the S. A. Andrée ballooning expedition to the North Pole in 1897 (Andrée, Strindberg, and Fraenkel, 1930). This study was undertaken in 1997–2000 as a purely scientific investigation into the causes of death of these Swedish polar explorers and to document their campsite (Broadbent, 1998; 2000a; 2000b). The centennial of this expedition was 1997, and the project was supported by the Royal Swedish Academy of Science and the Nordic Research Council for the Humanities within the framework of a larger history of science program (Wråkberg, 1999).

The second study was undertaken in 1992 as an Antarctic environmental cleanup and cultural heritage management project. The United States Congress allocated environmental funds in 1991 to facilitate the cleanup of old American bases in Antarctica. One of these bases, East Base on the Antarctic Peninsula dating to 1940, is the oldest remaining American research station in Antarctica. The archaeological project was conducted through the auspices of the Division of Polar Programs at the National Science Foundation in collaboration with the National Park Service (Broadbent, 1992; Broadbent and Rose, 2002; Spude and Spude, 1993).

The third study, Marble Point, was directly related to the International Geophysical Year of 1957–1958. Marble Point is situated across the Antarctic continent from East Base and near the large American research station at McMurdo Sound. An enormous engineering effort had been put into building a 10,000-foot runway at Marble Point. This base was, nevertheless, abandoned when the U.S. Navy found its sea approach extremely difficult for supply ships. With the aid of volunteers from McMurdo in 1994, it was possible to map the remains of the SeaBee (Navy Construction Battalion Unit or CBU) base camp at Marble Point (Broadbent, 1994). It was in this context that the science that had gone into the prospecting of the airfield became apparent, as well as the impacts that construction had left on the landscape.

The combination of history, archaeology, and natural science is an exceptionally productive approach to understanding the past and applying this knowledge to modern research questions.

THE ANDRÉE NORTH POLE EXPEDITION IN 1897

The Andrée expedition is one of the most intriguing in polar history. Solomon August Andrée (1856–1897) worked at the Swedish patent office. He had become fascinated by ballooning after visiting the U.S. centennial celebration in Philadelphia in 1876. On returning to Sweden, he devoted himself to designing hydrogen balloons that could be used for exploration and aerial mapping. His greatest effort was put into the design of the *Eagle*, which was intended to take him and two colleagues to the North Pole using southerly winds. A balloon building and hydrogen generating facility were built on Dane Island in northwest-

ern Svalbard in 1896 (Capelotti, 1999). The first attempt on the North Pole was aborted because of poor winds and gas leakage. A new team consisting of Andrée, Nils Strindberg, and Knut Fraenkel (replacing Nils Ekholm) launched in the *Eagle* on 11 July 1897. They were never seen alive again. Interestingly enough, Nils Ekholm, who quit the project which he felt was too risky, was seen by many as a coward and his decision is still being debated in Sweden. He went on to become one of Sweden's most prominent meteorologists.

In 1930, the bodies of Andrée, Strindberg, and Fraenkel were found at their campsite on White Island in eastern Svalbard (Lithberg, 1930). The bodies were returned to Sweden, cremated, and buried in Stockholm following an almost royal funeral and national day of mourning (Lundström, 1997). An exhibit of their equipment was shown at Liljevalch's Art Hall in Stockholm in 1931 (*Fynden på Vitön*, 1931). Remarkably, their diaries and notes, as well as undeveloped roles of Kodak film, had survived. A number of negatives could be developed and these images provide a haunting picture of their ordeal.

The balloon had gone down on the sea ice on 14 July 1897. Because of icing the balloon could simply not stay aloft and after 33 hours of misery the decision was made to land. They had reached 82° 56′ north latitude (Figure 1). They were well equipped with sleds and a boat and from 14 July until 5 October they trekked on the sea ice, first eastwards, making little real distance because of the ice drift, then southwards. They were planning on wintering in a comfortable snow house near White Island and celebrated the king's birthday on September 18 with a meal of seal meat, liver, kidneys, brains, and port wine. They were in fine spirits. Then disaster struck when the ice fractured under their snow house. Luckily the weather was good. They systematically gathered their equipment and supplies and were forced to go ashore on White Island where they set up a new camp. The last note in their diaries has a date of 17 October. There is little in the diaries about being in a critical situation. There were no last words or explanations, letters to their loved ones or to their sponsors. It seems that they had no inkling that they were in danger of dying. By comparison, Robert Falcon Scott and his companions took the time to leave a number of letters when they understood their situation. They knew at some future date their camp and bodies would be found. As Andrée and his companions were now on dry land one would assume that, if they had known that all was lost, they would have done the same. They were well aware that the world had been watching them and considerable national prestige was at stake, particularly since the Swedish king, Oskar II, and Alfred Nobel were official sponsors.

FIGURE 1. The *Eagle* shortly after landing on the sea ice at 82° 56' N on 14 July 1897. Andrée and Fraenkel are looking at the balloon. The image was developed from a roll of Kodak film recovered from White Island in 1930. (Photo by Nils Strindberg, courtesy of Andrée Museum. Gränna)

Strindberg's body was found in 1930, half buried in a rock crevice near the campsite, indicating that he had been the first to die. Fraenkel lay dead in the tent and Andrée lay on the rock shelf above the tent.

There have been many theories but no conclusive evidence for how or why they had died. The campsite that had been mapped during the recovery in 1930 had been largely buried in snow and ice (Lithberg, 1930). Warming trends in the Arctic made it likely that the site would be better exposed today. A new investigation in connection with the centennial of the expedition was organized and subsequently funded.

FIELDWORK IN 1998

The first project expedition to Svalbard was undertaken in 1998 on the Norwegian research vessel *Lance* through the auspices of the Swedish Polar Research Secretariat and the Royal Academy of Sciences. The participants included science historian Sverker Sörlin, the director of the Andrée Museum, Sven Lundström, Nordic Museum ethnographer and polar historian, Rolf Kjellström, archaeology student Berit Andersson, and the author. The team visited White Island for one day and

mapped the immediate camp area using standard mapping techniques and photography.

The site, as hoped, was found to be totally free of ice and snow cover and even the margins of the tent were still discernable in the sandy soil. Embedded in the tent depression were frozen remnants of clothing. Driftwood, bamboo, silk shreds, metal fragments, and other small debris were scattered on the soft sand. Even fragments of bone, certainly polar bear and seal bone, but possibly even human, were found (Figure 2). The area surrounding the site also produced artifacts, including opened food tins from the expedition.

With this archaeological potential, a follow-up project was proposed in order to map the site using digital technology and to conduct a soil chemistry analysis in order to map the non-visible areas of the camp and evidence of camp use. It was reasoned that low levels of phosphates, by-products of defecation, urination, and animal carcasses, could also reflect length of site use. Magnetic susceptibility would tell us about burning on the site. A pile of driftwood still lies near the tent site and had been collected by the Andrée team as construction material as well as for fuel.

From the initial inspection it was possible to verify the archaeological potential of the site and its surroundings. Although most objects had been collected in the 1930s, the ground was still littered with small debris including silk and bamboo from the balloon and boat, tin openers and various metal fragments. This micro-deposition reflected the extent of the former campsite. The tent and its half frozen floor deposits presented an excellent opportunity for study.

Among the most interesting conclusions of the survey was that this campsite had been well chosen. It was on well-drained sandy soil and protected by a rocky outcrop. There was a small stream nearby. In addition, the camp was situated well back from the shore and away from areas where polar bears would prowl. Considerable effort had clearly been put into choosing this spot and substantial piles of logs had also been assembled for dwelling construction and/or fuel. We know from a note in Andrée's journal that the camp had been named "Camp Minna" after his mother.

FIELDWORK IN 2000

Having received permission by the Norwegian authorities to conduct the study, we returned on the Swedish chartered ship *Origo* to White Island on 19 August 2000 (Broadbent and Olofsson, 2001).

The goal of the investigation of the Andrée site was to archaeologically document the camp and its surroundings and to assess the potential causes of their deaths. The men did not appear to be either ill-equipped or desperate on going ashore on 5 October 1897. They had established a good campsite on dry ground. They had fuel for their stoves, ammunition, food, and medicines.

With this goal in mind, a new potential for analysis at the site emerged in 2000. Mark Personne, MD, of the Stockholm Poison Center, had just published an article in the *Swedish Journal of Medicine* in which he assessed the symptoms of the three men that could be gleaned from their diaries (Personne, 2000). Suicide, murder, depression, trichinosis, hypothermia, carbon monoxide poisoning, alcohol/fuel poisoning, and so on had been proposed in the past, but Personne deduced that the most probable cause of death for all three men was botulism poisoning.

Botulism Type E is common in the Arctic and is found on the skin of marine mammals that pick it up from bottom sediments and in the near-shore environment. It is tasteless and odorless and among the most deadly poisons in nature. Once ingested, death occurs within 24–36 hours (Personne, 2000, plus references). As a neurotoxin, it affects the central nervous system. For our purposes, although the bacteria would be long gone, it was technically possible to identify the botulism toxins in the soils of the camp, namely in the area of the tent floor. Testing this theory thus became a new target of the investigation.

The first setback was to discover that the campsite was now buried under as much as 30 centimeters of ice. Snows from the previous two winters had melted into a hard mass which could only be hacked out with difficulty. That evening a heavy snow storm with gale-force winds hit the island and the team was unable to go ashore for two days. Some 20–30 inches of snow now covered the island and the initial survey plans, which had already rendered several interesting finds, including one of the three sled yokes from the expedition, were not possible. The planned excavation of the tent floor to test Personne's theory was also no longer possible. The focus returned to the topographic mapping of the site and sampling for phosphates and magnetic susceptibility. Ground level could still be determined with our measuring rod and soil samples could still be collected.

WHAT THE SOILS REVEALED

The Andrée camp on White Island is situated at 80° 05′ N and 31° 26′ E. The camp was about 175m from the shore in sandy terrain and adjacent to a 3m high stone outcrop. The site area covers about 250 square meters. From

FIGURE 2. The Andrée campsite in 1998 was completely exposed. Fragments of the balloon, clothing, and other items were visible. (Photo by Noel Broadbent)

the perspective of soil chemistry, the site is analogous to the environment of Late Post Glacial hunters living near the ice margins of Scandinavia 9,000 years ago. In an environment like this, almost all organic and phosphate-containing materials were brought to the site by man or beast. Indications of burning were certainly an indication of human presence. Small groups of hunters slaughtering and subsisting on animals left relatively high phosphate deposits in the same types of soils. These inorganic phosphates bind with the soil and remain for thousands of years. Citric acids releases the phosphate and this can be measured using colorimetric (phosphorous-molybdate)–based methods. Johan Olofsson provided the expertise for soil sampling and analysis (Broadbent and Olofsson, 2001).

The human body processes 1–2 g of phosphorus per day (Devlin, 1986). In addition to the deposition of food residues, especially bones, urination and defecation contribute to the buildup of phosphate in the soil. The longer a site is occupied, the greater will be the phosphate enrichment. This buildup is expected to be greatest in the site center or adjacent to the center. Since this is a relative measure, differences of 5 percent or more are considered significant as related to offsite normal background sample values. The team collected 240 soil samples in the camp area.

Phosphate is measured in phosphate degrees, mg P2O5 per 100 g dry soil. The mean phosphate enrichment in the site center was 17±9 P° with a range of 38–2 P°. The highest values were actually to the north of the camp margin and associated with water pooling that was a natural process. The average off site values were 11±11 P° with a range of 38–1 P°.

Although the site areas averaged slightly higher than the control samples, this was due to natural drainage on the site rather than human activity. In fact, the map of phosphate values shows that the immediate tent area no enrichment whatsoever. This is strong evidence that they had not been active on the site for very long before death overcame them.

Magnetic susceptibility (MS) on the campsite averaged 5±4 SI which is comparable to the off site control measurement of 4±2 SI. One sample on the site measured 40 SI because of a rusty flake in the soil sample and this raised the average campsite value. MS is measured in SI units per 10 g of soil using a Bartington MS2B measure cell (Thomson and Oldfield, 1986).

Magnetic susceptibility rendered no evidence of fires and the low phosphate values suggest that the site had hardly been used.

The three men had arrived on the island on 5 October 1897 in relatively good shape, searched out an excellent campsite, collected heavy driftwood logs for construction of a hut, and then died within hours of each other. They managed a simple burial of the youngest member of the expedition, Nils Strindberg, and then barely made it back to the tent where they collapsed. Andrée was found with a Primus Stove, which was easily re-lit after 33 years in the snow. Fraenkel was lying on or beside, not in, his sleeping bag.

The Personne hypothesis on botulism poisoning could not be tested but remains the most probable cause of the sudden death of all three men. The lack of final words and letters in the otherwise preserved papers supports the idea as well. With exposure to a neurotoxin, the men would have been quickly immobilized and were apparently unable to write. Oddly enough, Fraenkel was found still wearing his dark glasses in spite of the low light in early October. Light sensitivity is another symptom of botulism (Personne, 2000). A follow-up sampling of the site might one day help prove this theory.

Andrée and his companions still capture the imagination of the public, especially in Sweden. The fact remains that Andrée was the first pioneer of polar flight and aerial photography in the polar regions. While in some quarters he is viewed as a "balloonatic" who knew this was going to end in disaster, to others he is revered as a genius of balloon design. In 2000, the same year of the investigation of his campsite on White Island, an English adventurer, David Hempelman Adams, launched his hot air balloon,

the *Britannic Challenger*, from Longearbyn in Svalbard. He reached the North Pole and most of the way back in 133 hours, thus proving that Andrée's plan had been feasible all along.

Every year the Andrée campsite is visited by numerous tour groups. We noted during our first visit in 1998 that the soft soils of the site were badly disturbed and the area between the site and the shore was dimpled with thousands of deep footprints.

EAST BASE AND THE UNITED STATES ANTARCTIC SERVICE EXPEDITION (1939–1941)

In 1939, President Franklin Roosevelt appointed Rear Admiral Richard E. Byrd to command the U.S. Antarctic Service Expedition. Roosevelt was well aware of German territorial interests in Antarctica; that same year the German Antarctic Expedition on the seaplane tender *Swabenland* claimed 200,000 square miles of territory, including Crown Princess Maerta Land, which had been a Norwegian claim. Most important coastal points were marked with swastikas and flags dropped from aircraft. Germany invaded Norway in 1940 (Broadbent and Rose, 2002).

Two American bases were quickly established in Antarctica in 1940: West Base under the command of Paul Siple, and East Base under the command of Richard Black (Black, 1946a, 1946b). West Base was built on the Bay of Whales and has been lost in the sea, but East Base, built on Stonington Island off the Antarctic Peninsula (68° 28′ S, 67° 17′ W), still stands.

East Base was hastily abandoned on 22 March 1941 under the looming threat of war. The 26 men, with a smuggled puppy and a pet bird—Giant Petrel, later donated the

FIGURE 3. The abandoned East Base on Stonington Island, Antarctica. The Science Building with its weather tower and the Bunkhouse building were intact. The crate containing a spare engine for the Curtis Wright Condor biplane can be seen in front of the Science Building. (Photo by Noel Broadbent, 1992)

National Zoo in Washington, D.C.—abandoned the base and flew out to the ice edge in their Curtis Wright Condor biplane, which also had to be abandoned. The *USS Bear* then took them back to the United States, and some nine months later the United States was at war with Japan and Germany.

Stonington Island was reoccupied by the Falklands Islands Dependencies in 1946 and subsequently used by the British Antarctic Service until 1970 (Walton, 1955). East Base itself, although badly vandalized by ship crews from Chile and Argentina, was reoccupied by the Ronne Antarctic Research Expedition (RARE) in 1947–1948 (Ronne 1949; 1979). The RARE expedition was a private venture under the leadership of Finn Ronne who had been second in command at East Base in 1940. The RARE expedition was unique because this was the first time women (Jackie Ronne and the chief pilot's wife, Jennie Darlington) were to winter over in Antarctica (Ronne, 1950; Darlington and McIlvaine, 1956).

All three expeditions conducted important research and determined that this part of the continent was indeed a peninsula and not an island (Ronne, 1949: English, 1941; Wade, 1945). Interest in the historic value of the site was noted by Lipps in the late 1970s (Lipps, 1976, 1978). East Base was recognized as an historic site (#55) by the Antarctic Treaty Nations in 1989.

In 1991, U.S. National Park Service archaeologist, Catherine Blee (later Spude), and NPS historian, Robert Spude, were taken to the island by NSF to conduct a survey and develop a management plan for the site. In 1993, the author led a team, including archaeologist and hazardous waste expert, Robert Weaver, and staff from the U.S. Antarctic Research Program Base at Palmer Station and British Antarctic Survey personnel from Rothera Station. We were there to follow through on the NPS recommendations. These included cleanup and documentation of debris, removal of hazardous materials, repairs of doors, windows, and roofs and the storage of artifacts. In addition, warning and information signs were made for the site and its buildings and an interpretative panel with a description of the station and historic photographs was put on display in the Science Building (Figure 3).

The team worked on the site from 20 February until 3 March 1992. The grounds were cleaned and capped with fresh beach stones, the buildings repaired as far as possible and one building became an artifact storage facility. A collection of some 50 artifacts, including old maps, tools, mittens, films, bottles, bunk plates and dog tags with names, scientific specimens, medical supplies and other items were brought back and are now kept at the Naval Historical Center, U.S. Naval Yard, in Washington D.C. (Figure 4).

FIGURE 4. Noel Broadbent recording a cold-weather mask at East Base in 1992. In the foreground are old weather maps found at the site. (Photo by Michael Parfit)

A small museum, one of the most remote museums in the world (Iijima, 1994), was set up in the Science Building with and a brass plaque with the names of the 1940–1941 and 1947–1948 expedition members that had been donated by the National Geographic Society. A guest book was left in the museum together with an American flag.

A spare engine for the Curtis Wright Condor biplane still rests in its original crate in front of the museum. There is even a World War I vintage light tank with an air-cooled aircraft engine, a failed experiment in winter traction (Figure 5). The first tourists arrived in 29 December 1993 onboard the *Kapitan Khlebnikov*. In 1994, Jackie Ronne, widow of Finn Ronne, and their daughter, Karen Tupek, visited the site and left more photos and texts for the museum and the bunkhouse.

The East Base project was conducted as a cleanup and historical archaeological project. It was the first U.S. effort in historic archaeology in Antarctica that set a precedent for how sites of these types can be managed (Parfit, 1993). Sites in the East Base area were made environmentally safe and worthy of tourism and are lasting memorials to polar science. More than 100 cruise ships now visit Antarctica every year and there is still an urgent need to document and manage many historic sites around the continent. Preservation conditions have left items in pristine condition and the continent is littered with aircraft, vehicles, and buildings. This is one of the greatest challenges of cultural resource management and ideally should be conducted as collaborative international efforts.

FIGURE 5. The gap between Stonington Island and the Northeast glacier, 1992. As late as in the 1970s, an ice bridge connected the island to the Antarctic Peninsula; it had been the major reason for choosing the island as a base in 1940. The changes reflect rapid warming in the region. (Photo by Noel Broadbent)

MARBLE POINT, ANTARCTICA

The final project to be discussed is a small archaeological endeavor but one encompassing a huge site, that of a 10,000-foot-long airfield and base at Marble Point in Victoria Land, across from Ross Island and the large American base at McMurdo Sound.

While making site visits to researchers supported by the social sciences program as NSF, the author had the opportunity to carry out a survey of Marble Point on 22 January 1994. With the help of volunteers from McMurdo, we mapped the site of the Navy Seabee (CBRU) camp established in 1957. There were numerous foundations of "Jamesway" huts, trash dumps, oil spills, roads, and other features. Large vehicles, graders, and rollers had also been left behind. A reservoir dam been built at the foot of the glacier (Figures 6 and 7a–e). The U.S. Navy (Operation Deep Freeze I) supported American scientists in Antarctica during the 1957–1958 International Geophysical Year and this base was part of the effort. More than 40 nations participated in the IGY and the Antarctic was studied by teams from the United States, Great Britain, France, Norway, Chile, Argentina, Japan, and the USSR. Marble Point was both a research site and an ideal place for an airfield. It was also a jumping-off point for researchers working in the Dry Valleys.

Rear Admiral George J. Dufek championed the airfield construction. In an Airfield Feasibility Study film (CNO-5–1958), he pointed out the strategic significance such an airfield for the southern hemisphere. Aircraft could

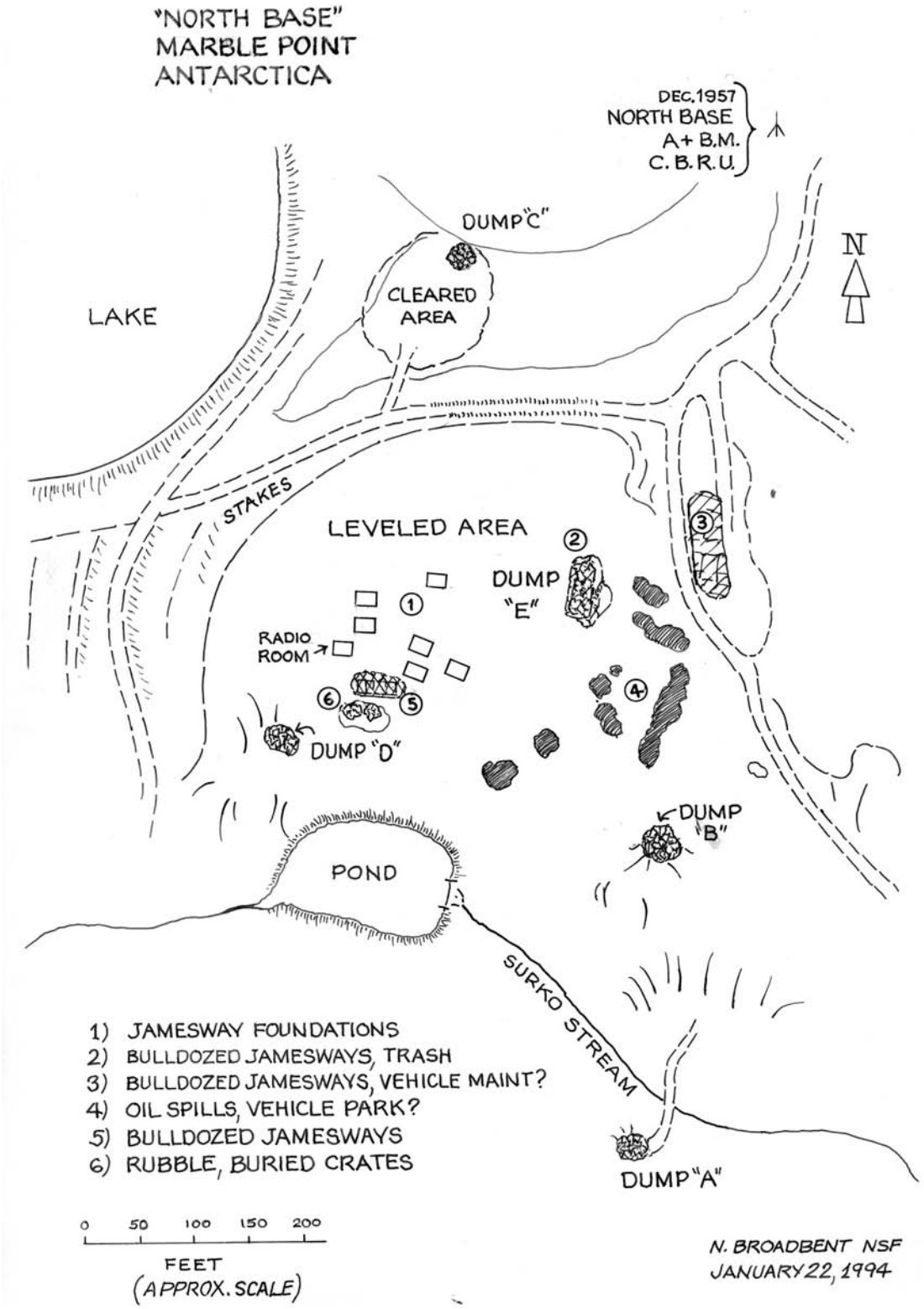


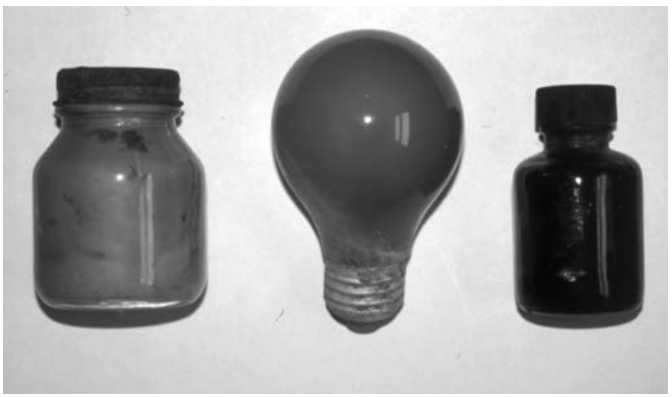
FIGURE 6. Archaeological map of the Navy SeaBee camp "North Base" from 1957 at Marble Point, Victoria Land, Antarctica. Map shows locations of "Jamesway" huts, trash dumps, roadways, and oil-spill areas where vehicles had been parked. (Produced by Noel Broadbent, January 22, 1994)

(a)

(b)

(c)

(d)



(e)

FIGURES 7a–e. Selection of items found at Marble Point and the remarkable preservation of paper and fabrics. (a) The newspaper cartoons from 1960 still have bright colors. These simple things, large and small, tell us about daily life and work at the base. (Photo by Noel Broadbent).

be rapidly deployed to South America, Africa, and other points north. The sea ice runways used at McMurdo were limited to only part of the year and had to be rebuilt each season. Further, while clearly advantageous for aviation, the icy coast of Victoria Land proved difficult for ships to use and the shores were shallow. The 10,000-foot runway was never finished. Notably, however, the first "wheels on dirt" landing of an aircraft in Antarctica took place here when a Navy VXE-6 squadron *Otter* landed with Sir Edmund Hillary onboard. He had just reached the South Pole in an overland tractor convoy.

Marble Point is a weather station and helicopter refueling station today. In the 1980s, when the Chinese program was considering the site as a potential research station, the VXE-6 commander, Captain Brian Shumaker, had new stakes placed along the runway to assert continuing American presence there. It remains an American site today, and is, without question, the best place for a year-round airfield on the continent. It is a rocky promontory located 50 miles from McMurdo Station, and an adjacent land strip serves as a helicopter refueling station in support of U.S. Antarctic program research.

Our survey of the Marble Point area revealed that an enormous engineering study had been conducted there in 1956–1957 by the U.S. Navy. There were test trenches in the permafrost, test pads established with the sensors still in place, and detailed reports by engineers and scientists. In all, the studies encompassed geology, pedology, permafrost studies, seismic studies, hydrology, glaciology, sea ice and sea bed studies, and polar engineering. This material provides an unparalleled 50-year baseline for studying changes in the Antarctic environment and the effects of human impacts over time.

SUMMARY AND CONCLUSIONS

Archaeology offers unique opportunities for research on polar history. In addition to adding new substance to material culture remains and a greater focus on individuals, the documentation of in situ features is a necessary prerequisite for historic site preservation. The loss of sites in the Arctic due to climate change is an enormous problem and increased erosion along Arctic beaches and rivers is destroying thousands of years of Arctic prehistory and history. These regions have been little documented as compared with the lower latitudes. New highly perishable artifacts and human remains are melting out of glaciers around the world.

The Andrée expedition study was conducted as a research project on the causes of the deaths of these explorers. As an immensely popular figure in Nordic history, hundreds of visitors visit the campsite every year, made even more accessible by global warming. Management of sites like this will require greater protection, but at the same time we must help facilitate visitors' needs through marked pathways, signs, and better information.

The second project, at East Base, was a cleanup and management effort that also served to document and protect the site. This kind of project should continue to be international in scope. In 1992, John Splettstoesser published an article in *Nature* regarding the melting of the Northeast glacier at East Base as evidence of rapid global warming (Splettstoesser, 1992). One of the principal reasons Stonington Island has been chosen as a base in 1940 was that the glacier connected the island to the peninsula. Today the glacial bridge has vanished and the island is separated by a wide gap of open water. The bridge had been there as late as the 1970s. Human presence at places like Stonington Island has, in other words, inadvertently given us baseline observations for documenting rapid climate change effects.

Finally, Marble Point, even as a small mapping effort, further reveals the indirect scientific value of former bases. This site is literally a climate-change data goldmine. The engineering baseline data from sites like this, collected for entirely unrelated reasons, are of great value for understanding human impacts in polar environments.

Polar flight plays a major part in these three investigations. Andrée was the first pioneer of polar flight. Byrd was at the forefront of polar aviation and in 1946–1947, after World War II was also instrumental in Operation Highjump. Ronne mapped 450,000 square miles of Antarctica in 1947–1948. Marble Point was the site of the first dirt runway landing and still remains the largest land airfield ever conceived of in Antarctica. Aviation was at the core of mid-twentieth-century exploration and the transition from dog sleds to aircraft has left an amazing legacy of technology at both poles.

The "old politics" of polar research, and the technological efforts put into them, are closely akin to those of international climate change research of today. The International Geophysical Year in 1957–1958 was, after all, conducted during the heat of Cold War.

The Arctic Ocean has, once again, drawn the close attention of the eight polar nations—the United States, Canada, Russia, Sweden, Norway, Finland, Iceland, Denmark/Greenland—as well as all other nations highly dependent

on gas and oil. The Antarctic, as international territory, is still a place where national presence is deemed critical. It would not be an exaggeration to state that the past is truly prelude to the most significant issues of the modern era. To ignore this history is to fail to recognize why the polar regions have long played such an important part in the economic and political history of the western world.

EPILOGUE

Since the logistical costs of archaeological projects in the polar regions are so great, they are rarely possible to carry out. A potential model for achieving a more comprehensive approach to documentation and cleanup could be to use volunteers under expert supervision on regularly scheduled tourist vessels. This would provide meaningful experiences for the public, facilitate polar heritage management, and offer unique opportunities for the tourist industry. This idea is currently being discussed by a consortium of polar historians and archaeologists. The Smithsonian has several sites of interest that would be ideal places to begin. One is the old town of Barrow, site of U.S. efforts in the original IPY in 1881–1883, and a second site is Fort Conger on Ellesmere Island, used in 1881 by the Greely Expedition

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