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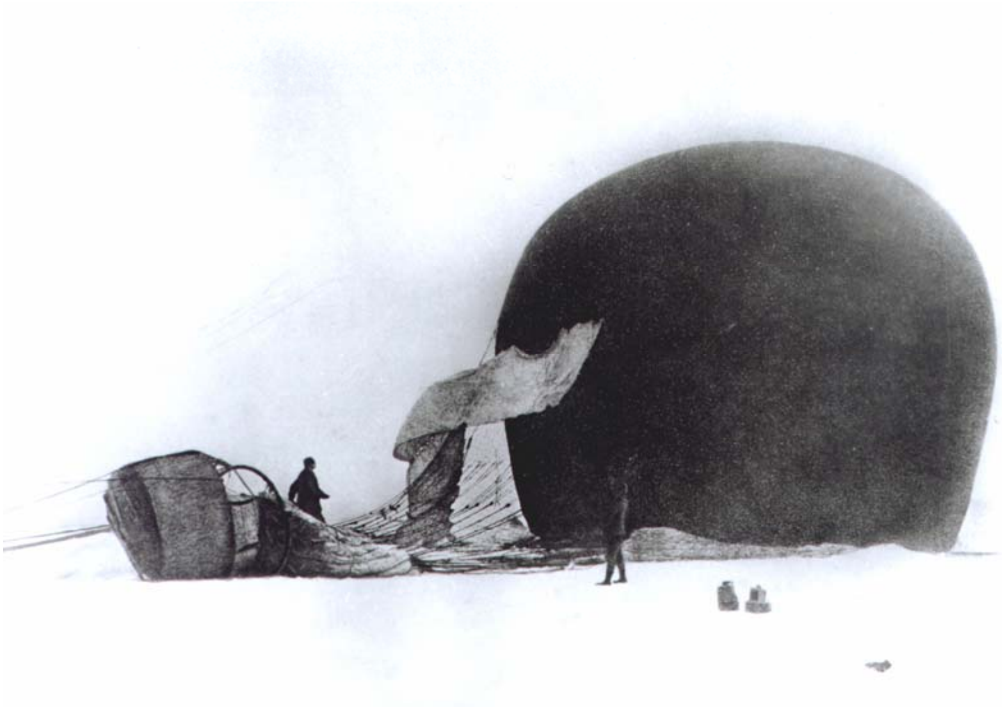
ARCHAEOLOGICAL INVESTIGATIONS OF THE S. A. ANDRÉE SITE, WHITE ISLAND, SVALBARD 1998 AND 2000.



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CONTENTS

Cover: The Eagle, July 14, 1897. Photo: Nils Strindberg. Courtesy of The Andrée Museum, Gränna.

LIST OF FIGURES AND TABLES

INTRODUCTION

This archaeological investigation of the Andrée expedition campsite originated as a part of "The Northern Space: Polar Research and the Nordic Nations" program which was funded by the *Nordisk Samarbejdsnaevn for Humanistisk Forskning* (NOS-H). Under these auspices an exploratory cruise to Svalbard was undertaken between August 8-16, 1997, followed by a conference at Longyearbyen commemorating the centennial of the S. A. Andrée North Pole Expedition (Wråkberg 1999). This conference presented a number of perspectives on the history of the Andrée expedition, including the archaeology of the Virgohamn site on Dane Island where the expedition started (Capelotti 1999: 30-43), speculation about the causes of their deaths (Kjellström 1999: 44-45), as well as a call for reappraisal of the expedition (Wråkberg 1999: 56-99).

It was clear from this conference that there is still little consensus about how the three expedition members, S.A. Andrée, Nils Strindberg and Knut Fraenkel, had died or whether the expedition had, indeed, been folly. Although Virgohamn had been studied using archaeological and analytical methods (Capelotti, 1997, 1999), there has never been any systematic documentation of the campsite or grave on White Island. As one of the great historical figures of Swedish exploration, Andrée still holds a special place in the Swedish mind and White Island has been getting regular tourist visits at an increasing rate. Taken together, these facts strongly motivated an inspection of White Island to assess the archaeological potentials of the site and the need for protective measures of site deposits. Archaeological mapping of the site and its surroundings had never been undertaken and the only documentation is the sketch map from 1930 based on initial observations by the *Bratvaag* expedition under Gunnar Horn and later by the journalist Knut Stubbendorf, who arrived at the site some weeks later on the *Isbjörn* (Lithberg 1930: 209). At this time the site was still partially covered by snow and ice. Recent warming trends in the Arctic suggested that more of the site and its surroundings could be exposed today.

The following report is an account of two field expeditions in 1998 and 2000, the research plans for this work, and the results of these investigations. Suggestions for further analysis are also presented.

Fieldwork planning

In 1998, under the auspices of the Swedish Programme for Social Science Research in the Polar Regions and the 1998 Swedarctic Svalbard Cruise under the direction of the Swedish Polar Research Secretariat, it was possible to make a landfall on White Island. The campsite was located and during the day of August 19, 1998, photographed, partially mapped and examined using a metal detector. Until this visit, the state of the camp and its archaeological potentials were unknown. In the following report, this documentation will be presented along with the motivations for additional fieldwork. A request to carry out this follow-up project was submitted to Norwegian authorities by the Center for the History of Science at the Royal Swedish Academy of Sciences on November 24, 1999 and subsequently granted on May 5, 2000. The follow-up archaeological project was conducted on August 29-September 1, 2000.

Team members and funding

The 1998 team consisted of Noel D. Broadbent (Umeå University), Berit Andersson (Umeå University) and Sven Lundström (The Andrée Museum, Gränna). The Swedarctic Svalbard cruise was undertaken aboard the Norwegian research vessel *Lance*.

The research team of the 2000 project consisted of Noel D. Broadbent (Umeå University) Annie Lindgren (Umeå University), David Loeffler (Umeå University), Johan Olofsson (Umeå University), Håkan Joriksson (The Andrée Museum, Gränna) and Lyder Marstrander (Directorate for Cultural Heritage, Oslo). The Swedish Program for Social Science Research in the Polar Regions cruise was undertaken on the chartered vessel *Origo*.

The Director of both Andrée fieldwork projects was Noel D. Broadbent, Professor of Archaeology at Umeå University. The head of the cultural historical program was Dr. Urban Wråkberg, Royal Swedish Academy of Sciences.

Funding for these projects was provided by the NOS-H and the Swedish Polar Research Secretariat. Additional support for the project was provided by the Royal Swedish Academy of Sciences, the Department of Archaeology at Umeå University and the Environmental Archaeology Laboratory at Umeå University.

Site history

The Salomon August Andrée expedition is one of the most fascinating chapters in polar aeronautics. The background and history of the attempt to reach the North Pole and transect the Arctic Ocean using a hydrogen balloon is well known through the Andrée commission book: *Med Örnen mot polen. Andrées polarexpedition* 1897 (1930) (*Andrée's Story. The Complete Record of His Polar Flight, 1897*). This publication was produced the same year that Andrée's camp and expedition belongings were found on White Island), and was translated that same year into numerous languages. The recovery of the artifacts was undertaken by the initial discoverers from the sealer *Bratvaag* that had been chartered for an expedition to Franz Joseph Land. The camp was found on August 6 and the bodies of Strindberg and Andrée, their boat filled with equipment, and other items were taken onboard. The *Bratvaag* expedition informed the crew of the *Terningen* of the find and then continued on to Franz Joseph Land until August 26th. The next visit to the site was by the newspaper journalist Knut Stubbendorf who had hoped to intercept the *Bratvaag* but ended up going directly to White Island onboard the vessel *Isbjörn*. He arrived on September 5th and worked on the site until September 7th. Stubbendorf made a very systematic search and collection of the site, produced a sketch map of the finds, and took a number of photographs. Stubbendorf's efforts, most significantly, included his subsequent work with the recovery and drying of diaries and the retrieving of film canisters with exposed film.

The site is protected under Norwegian law and inspected annually. In spite of this, one tourist group managed to erect and cement an unauthorized engraved "headstone" commemorating the Andrée centennial. It was demolished by the Norwegian authorities in 2000. Besides the official cement block and plaque from the 1930s, there are also miscellaneous wooden and cement markers.

Figure 1 Map of Svalbard

THE ANDRÉE NORTH POLE EXPEDITION

Background

With financial support of King Oskar II, Alfred Nobel, Oskar Dickson and Gustaf Retsius, Andrée was able to put together his expedition in 1896, which involved the construction of the balloon and gondola, the equipment and materials needed to produce hydrogen at the starting point by Virgohamn on Dane Island (Danskøya), and a large balloon house for the launch.

The scientific goal of the expedition was stated as follows:

"The main object of the expedition shall be to explore as much as possible of the North Pole region geographically." (Andrée et al. 1930: 33)

The plan was to use southerly summer winds to drift northwards from Dane Island. The balloon was intended to stay aloft for 30 days and, using an average speed of 16.5 miles (27 km) per hour, the North Pole could be reached in 43 hours. In six days the balloon would reach the Bering Straits. The design of the balloon included steering and ballast lines intended to help maintain both direction and elevation over ice and sea. Andrée states: "...it is not only possible to carry out a balloon journey across the polar tracts, but that there is much in favor of making an effort to do so."[1] Further, "Who are better qualified to make such an attempt than we Swedes."(Andrée et al. 1930: 36).

The team put together some 650 kilograms of equipment including a silk tent, three sleds, a boat frame and silk cover, 767 kg of food, 200 kg of water and fuel for the primus stoves. They also brought 13 message buoys and 36 carrier pigeons. For hunting and defense, they had three guns. For documentation and aerial mapping they had two cameras, one with a stereoscopic lens system, and roll film for up to 1440 exposures. They brought a medical kit, various surveying equipment (sextants, compasses, chronometers, barometers), sampling containers and vials, tools (an axe, saw and scissors chisels, files, drills, screws etc.), scales, tapes, books, journals and maps. Much of this material was recovered from the camp on White Island and a complete catalogue was published in connection with memorial exhibit in January 1931 at the Liljevalch's Konsthall in Stockholm(1931).

Figure 2 This advertisement in the Liljevalch catalogue is entitled "From the beginning to the end."

Two caches of food and supplies had also been established on the Seven Islands (Sjuøyane) north of Northeastland (Nordaustland) in Svalbard and at Cape Flora in Franz Joseph Land, to the east. These supplies were intended to support an over-wintering if this proved necessary. Unfortunately, neither proved reachable because of ice drift.

The first attempt to carry out the balloon expedition, with Andrée, Strindberg and Nils Ekholm, was aborted in August 1896 because of a lack of sufficient southerly winds and bad weather. It was also discovered that the balloon was leaking badly. Because of this situation, Nils Ekholm, whom was a meteorologist, decided to quit the expedition altogether which he considered too risky. His main concerns were the problems with the balloon and the weather conditions. Nils Ekholm died in 1923 and, although he had a very successful career in meteorology, he was never forgiven by the public for abandoning the expedition and his colleagues.

The start, and arrival on White Island

The second attempt, now with the civil engineer Knut Fraenkel instead of Ekholm, led to the launch at 1:50 pm on July 11, 1897. There was an immediate near-disaster when the

[1] The concept of using southerly winds to reach the North Pole was proven correct in the summer of 2000. The British balloonist David Hempelmann Adams launched his hot air balloon, the Britannic Challenger, from Longyearbyen in Svalbard. He reached the North Pole and returned back to the north of Spitsbergen in 132 hours, thus demonstrating that Andrée's concept had been feasible as he had originally predicted

balloon dipped dangerously and nearly went into the water. In addition, the heavy steering lines had become unscrewed and left onshore, thereby eliminating any possibility of steering the balloon in the coming days. The balloon did head off in the right direction, however, but after 65 hours and 33 minutes in the air, was finally abandoned on the sea ice at 82° 56′ N latitude (see cover photo). The balloon had traveled 480 kilometers. The failure of the flight was due, above all, to the foggy conditions and the subsequent condensation and icing on the balloon. It could not maintain its lift and only rose when hit by sunlight. After bouncing on the ice for many hours, it was decided to abort the flight.

From July 14 until October 5, Andrée and his companions were on the sea ice, making no headway towards either of their caches. They were in good spirits as they built their winter house, "Hemmet" on the sea ice off of White Island (Figure 3). They were healthy and prepared for winter on September 28, judging from the diaries, but the ice broke apart under their home on October 2 and they had to gather their equipment and meat supplies and make for shore.. Andrée named the new camp "M (ina)" after his mother. From this point on there is little information about the expedition in the diaries and no photographs were preserved. According to the notations in Strindberg's diary, the first man to die, they were alive until October 17. This meant they were on White Island for at least 12 days following the break up of their winter quarters on the sea ice and the three days it took them to get to the ashore.

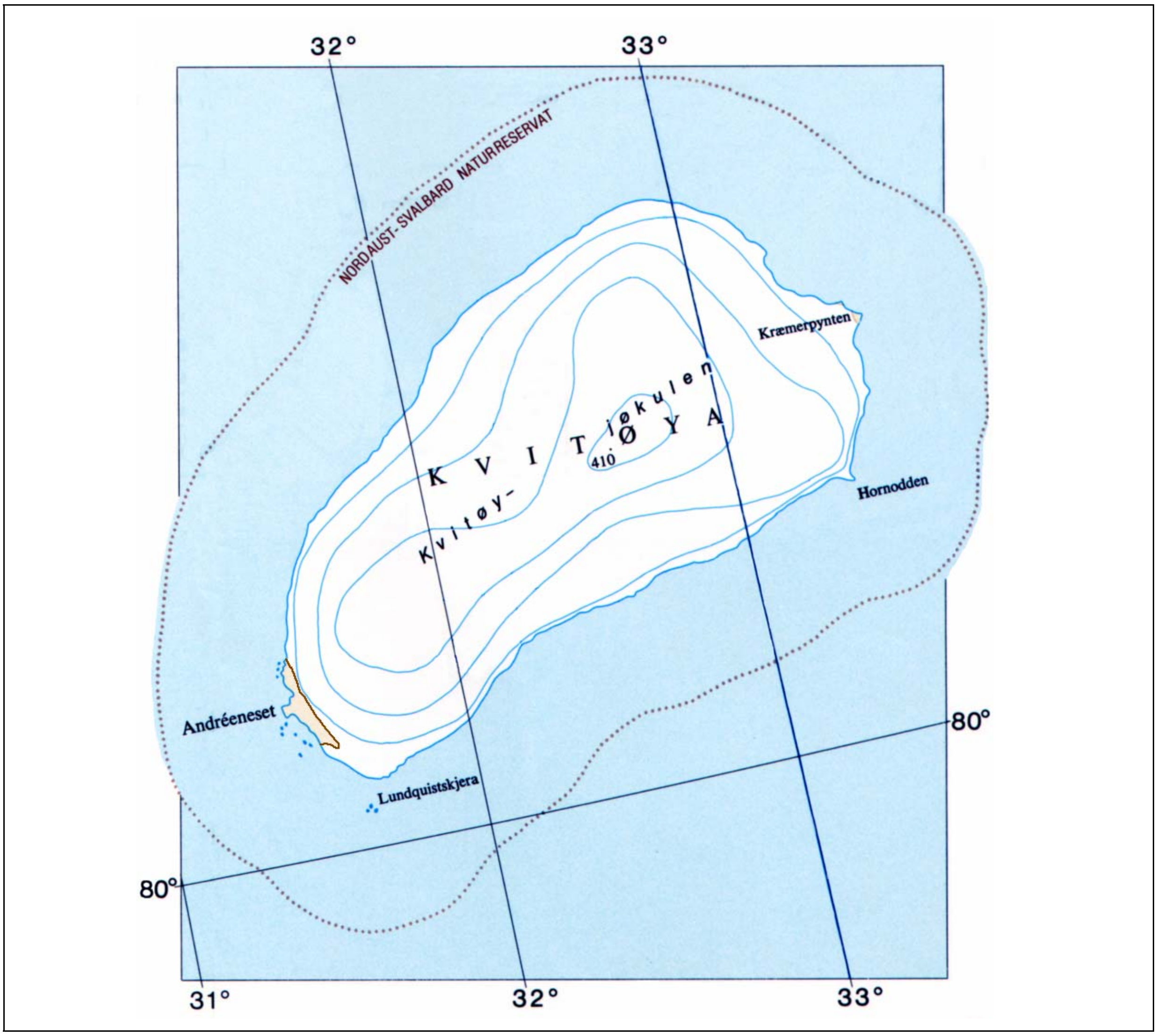

Figure 3 Map of White Island.

Causes of death

The great mystery of the expedition is not so much that the flight had failed, but why they men had died. They had food, water, fuel and a dry land camp. Even if weakened, it seems unbelievable that these enthusiastic men would have lost heart and died. Many other explorers have found themselves in far worse circumstances and survived their ordeals. The speculations as to the cause of death are many and include suicide (opium or morphine from the medical kit), trichinosis poisoning (polar bear meat), dehydration, vitamin A poisoning (polar bear liver), lead poisoning (the food cans), carbon monoxide poisoning (the stove), scurvy or just freezing to death (hypothermia). In a recent medical assessment of all of the potential symptoms as revealed by the diaries, the probabilities of these causes are evaluated and a new theory proposed: botulism or food poisoning (Personne 2000). Dr. Mark Personne of the Stockholm Poison Center, argues that none of the other theories is sufficient to explain the deaths of all three men within such a short period of time. Strindberg had been hastily and only partially buried. The other men lay dead in and near the tent and seem to have quickly succumbed.

Personne suggests instead that the sudden deaths, within one to two days, and the lack of diary notations, and even light sensitivity (Fraenkel was found wearing his sun glasses!), are consistent with botulism poisoning. This bacterium (Clostridium botulinum) and the neurotoxin it produces is a frequent cause of death in the Arctic and connected with marine mammals that pick up the bacteria from bottom sediments. The Andrée team had shot a seal on September 19 and they had this frozen meat with them on their arrival on White Island. But botulism could have originated from their air tight food cans. Insufficient heating could have led to poisoning. Symptoms start within 12 to 36 hours and death, following gradual muscle paralysis, occurs 6 to 8 hours after that. This would have given them time to bury Strindberg, followed shortly thereafter by their own deaths (Personne 2000:1432). As the bodies were badly mauled and skeletized by polars bears, a full autopsy was never performed and the bodies were cremated.

In spite of the various arguments for causes of death there is still no consensus as to why these men died. An analysis performed in 1979 of one of three fingernails found in a mitten at the Andrée museum in Gränna showed that there was an unusual amount of lead found in these nails. But growth rings showed that this had occurred before the expedition had begun. (Personne 2000:1431). It is possible that life in industrial Stockholm, not food containers, was the source. As far as identifying bacterial toxins, the museum collections are of limited value. All clothing had been washed in formalin and prepared for display. No unopened food cans were recovered. The only way to gain more resolution in this matter is thus from testing of clothing and/or samples collected from the camp site itself. The potentials at the site for such a study were unknown.

The oddest aspect of this final chapter is that these men, who were very aware of their public and political importance, left us no words before facing their imminent deaths. If all were lost, these literate men surely had the time and resources to tell us of their courage and friendship, and to write letters to their loved ones. If they were freezing to death, they would have had time to note this and give us some insight into their situation. The most logical reason for not doing so would have been the loss of visual and muscle control that Personne ascribes to botulism. All other contributing factors would probably not have stolen this last opportunity to record their thoughts.

THE PROJECT GOALS

As stated above, the cause of death issue was an important argument for studying the site. With luck, some toxins could still be preserved in the frozen soils. But this was a long shot. Soil chemical analysis, including phosphate analysis, could also be used to roughly see how the camp had been used and for how long. As an analogue to hunter-gatherer camps, there could have been a heavy enrichment of soil phosphates and traces of burning. The Andrée site (Camp Mina) is, as a short term tent site with game animal carcasses, an analogue to a late post-glacial campsite environment. Little or no research has been conducted on the chemistry of recently deglaciated coastal soils. This site therefore has intrinsic scientific value beyond that of its own historical context.

Of equal importance, however, is the issue of the site as a cultural historical resource. This camp surface has never been properly mapped and documented. The secondary levels of deposition, i.e. the items not picked up and brought back to Sweden, were an unknown feature of this site. With literally hundreds of tourists making it to the island every year, this historic site, the most sensational tourist attraction in Svalbard, is undergoing major impacts from trampling and, undoubtedly, inadvertent movement of materials and the outright removal of small token finds. There has, furthermore, never been a systematic survey and mapping of the areas surrounding the camp and much more material could possibly be found and documented. With all these issues in mind, the goals of the 1998 expedition were thus:

1) To assess the site and its surroundings with respect to any new find materials,

2) To initiate a surface mapping of the site,

3) To make recommendations regarding further documentation and protection of the site.

The site investigation in 1998

White Island is located at c. 80° 05´N, 31° 26´E. The R/V *Lance*, a Norwegian research vessel chartered by the Swedish Polar Research Secretariat, approached White Island on the 19th of August. Due to fog we could not go ashore until 14:00. The weather was clear, dry and the temperature about 5 degrees centigrade. We remained on the island for approximately 6 hours.

The campsite is situated on Andrée Point (Andréenäset), 175 meters from the shoreline in gently sloping gravel and sandy terrain and directly adjacent to a ca 3m high rock outcropping. Additional smaller bedrocks protrude to the north and east of the campsite and a shallow stream bed runs parallel to the camp and down to the shore. The map of the site published in 1930 covers and area of ca 25 x 10 m with an inset sketch showing the Strindberg grave located about 30 m from the outcropping. This map (Figure 4) shows the open area around the sleds (the boat, two sleds, polar bear skins (Area A), the dwelling structure (Area B), the area in front of the dwelling structure (Area C), driftwood logs (D), Strindberg's grave (E1) and skull (E2), a cairn marking the site (F), a pair of stockings (G), and some boundaries of the stream bed

The campsite itself was very well chosen. It is situated on well drained sandy soil and protected from the winds by a three meter high rock outcrop. The sandy ground, which was easily excavated, provided a comfortable living surface. The phosphate map produced in 2000 (Figure 25), confirms the impression that the camp was well placed. The camp appears almost as an "island" as compared with the surrounding drainage areas. There was also a good supply of dry driftwood for construction and heating. The camp had an excellent view of the shore, but was well above it and protected from polar bears which tend to move along the beaches. White Island is a prime area for bears and seals so there would have been ample supplies of meat.

The camp was easily located in 1998 including the approximate outlines of the tent, the piles of driftwood shown in the sketch map from 1930, and through scattered metal fragments from the special food tins used by the expedition, sardine keys, bones, wooden splinters, bamboo pieces, fabric tatters, wires, screws, cordage and polar bear skin pieces etc. The site was totally exposed and dry.

The condition of the site was better than expected and the tent floor offered an opportunity to obtain samples for the analysis of toxins and artifacts *in situ*. The very soft sandy ground was easily imprinted by footsteps and very vulnerable to disturbance by visitors.

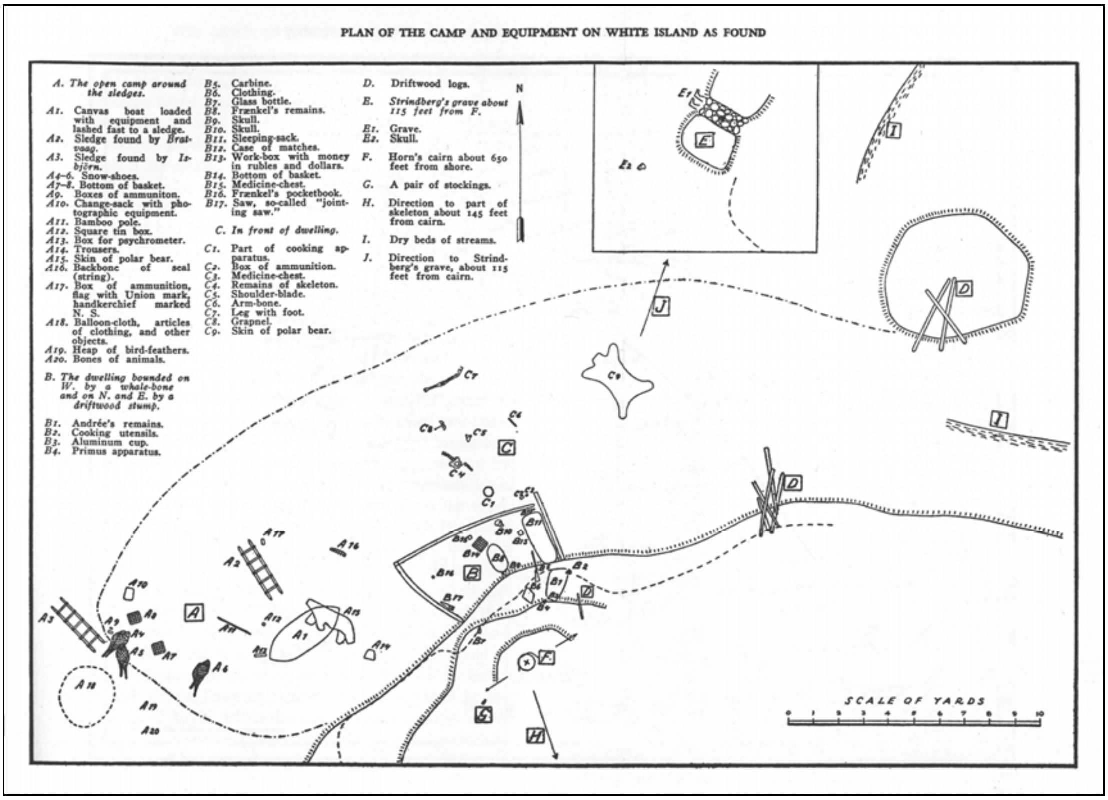

Figure 4. The Andrée camp at White Island. The map is based upon sketches from Gunnar Horn and Knut Stubbendorff together with information from interrogations made by Norges Svalbard- og Ishavs-Undersökelser (Andrée et al. 1930).

There are no elevations for the finds or features on the sketch map. As this map was done while there was still a considerable amount of ice and snow on the ground, it is not known if more material has been subsequently exposed. The tent outline was not discernable by the wooden and bone beams indicated in the sketch map, but by a narrow trench/ridge, which must have been dug for drainage. A depression in the tent floor had an ice core and a larger piece of clothing was visible imbedded in the ice. This looked like it could be a sweater or something similar with a loose weave. As we discovered in 2000, it was virtually impossible to carry out excavation on this spot if covered in snow and ice. The conditions in 1897 must therefore have been similar to those seen in 1998 (Figure 5 and Figure 6) and unlike those seen in 1930 and 2000 (Figure 12 and Figure 13). In other words, the ground surface must have been free of ice and snow when the camp was established. This adds to the argument that this camp would have been a good place in which to survive for an extended period of time.

Figure 5. Photo taken August 19, 1998, showing the camp site area looking south. The tent area is located adjacent to the rock outcropping in the centre of the picture roughly marked with a black line. The tent bottom is seen as a slight depression and a collection of small debris. Andrées body was found on the second slanting and sand covered rock shelf above and just to the left of the tent (marked with a box). Photo: Noel Broadbent.

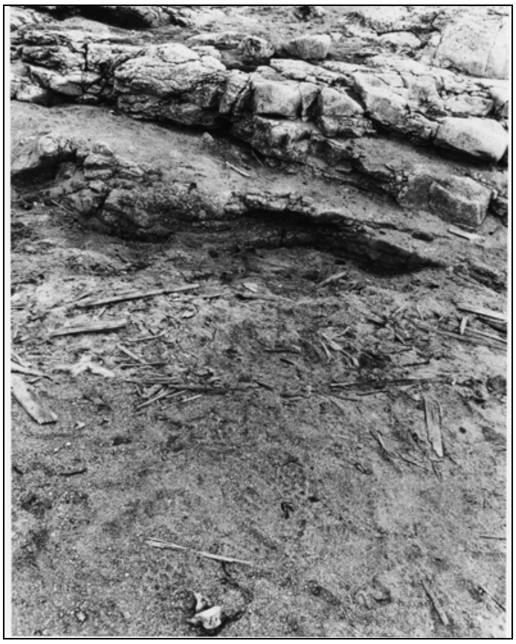

Figure 6. Close-up photos of the tent area as seen on August 19, 1998. A slight ridge in the sand marks the edge of the tent floor. Note footprints on the delicate site surface. Photo: Noel Broadbent.

A surface contour map

A meter grid was laid out on north-south and east-west magnetic lines adjacent to the rock outcropping. A datum point was established at the edge of the camp and determined as being 2.73 m above sea level. Elevation measurements were determined using a standard transit and a total of 260 elevation measurements were made of the site surface. These readings made it possible to construct a detailed surface map using 10 cm isarithms (Figure 7).

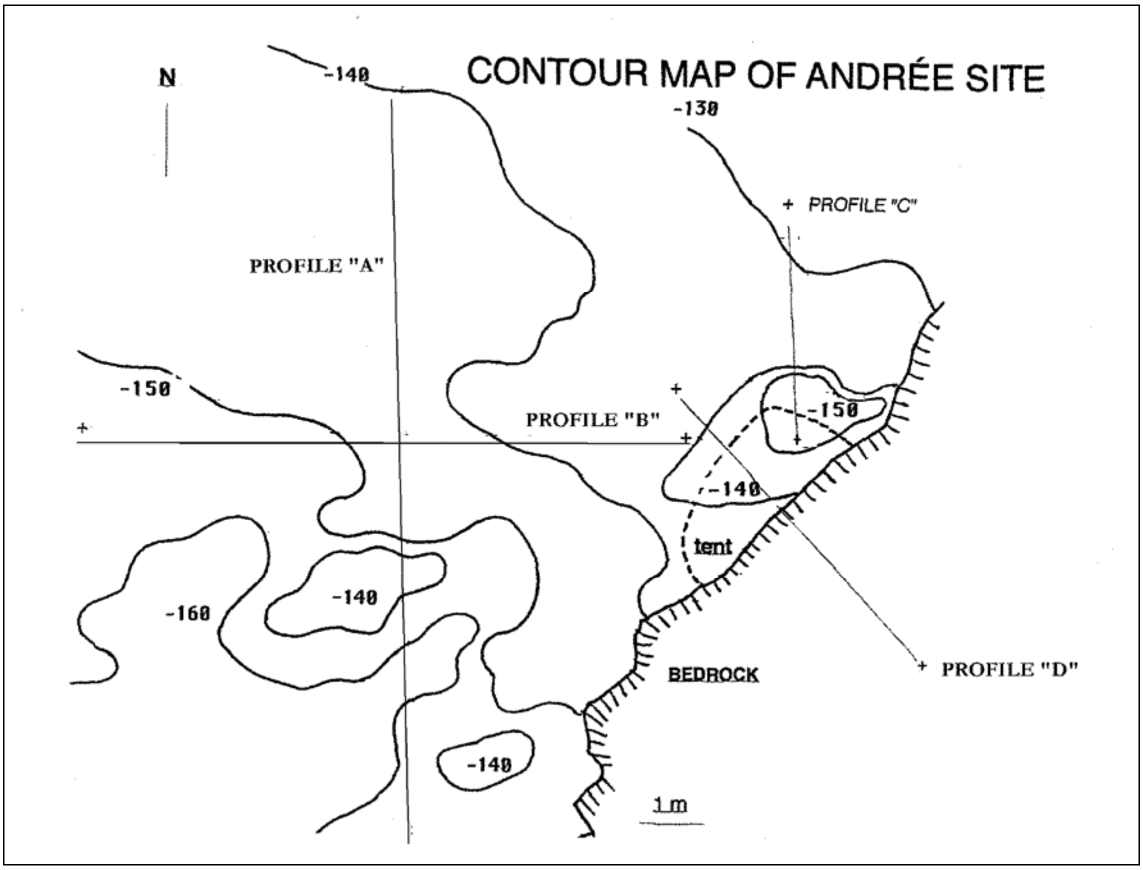

Figure 7. Map of site area showing 10 cm contour lines and the area of the tent depression. Elevations are relative to the height of instrument (1.30m) above the temporary datum. The gently sloping ground is slightly ridged. Straight lines indicate surface profiles. Map: Noel Broadbent.

Surface profiles

Four surface profiles were drawn across the site. Profile A runs north-south and extends for 35 meters. Profile B runs east-west for 18 meters and up to the tent floor. Profile C extends south-north from the tent area and is 6 meters long. Profile D is 9 meters long and runs from the tent and up to the top of the rock outcropping (Figure 8 and Figure 9).

These profiles show the relatively gentle ridging of the ground surface and Profiles C and D show the tent depression. Profile D shows the position of the tent against the outcropping including the shelf where Andrée´s body had been found. During the mapping of this profile a splinter of bone was found on the shelf and was left *in situ*.

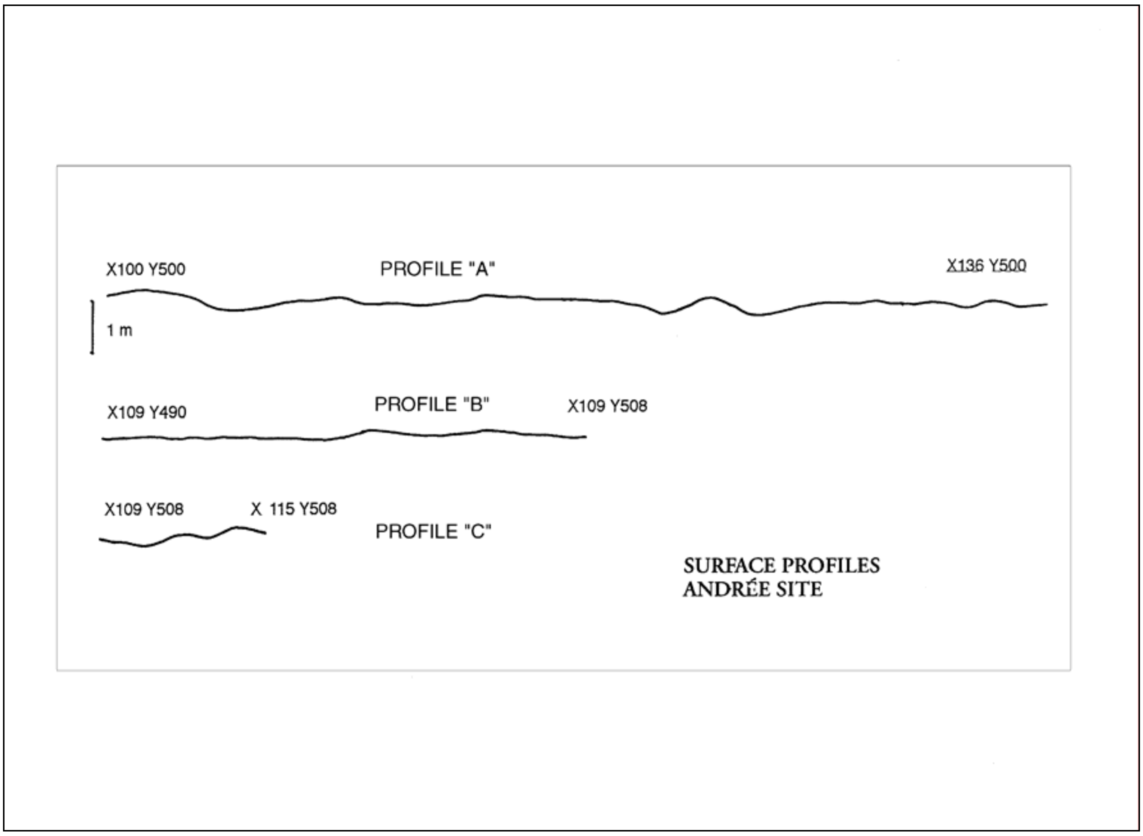

Figure 8. Surface profile A, B and C (refer Figure 7). Map: Noel Broadbent.

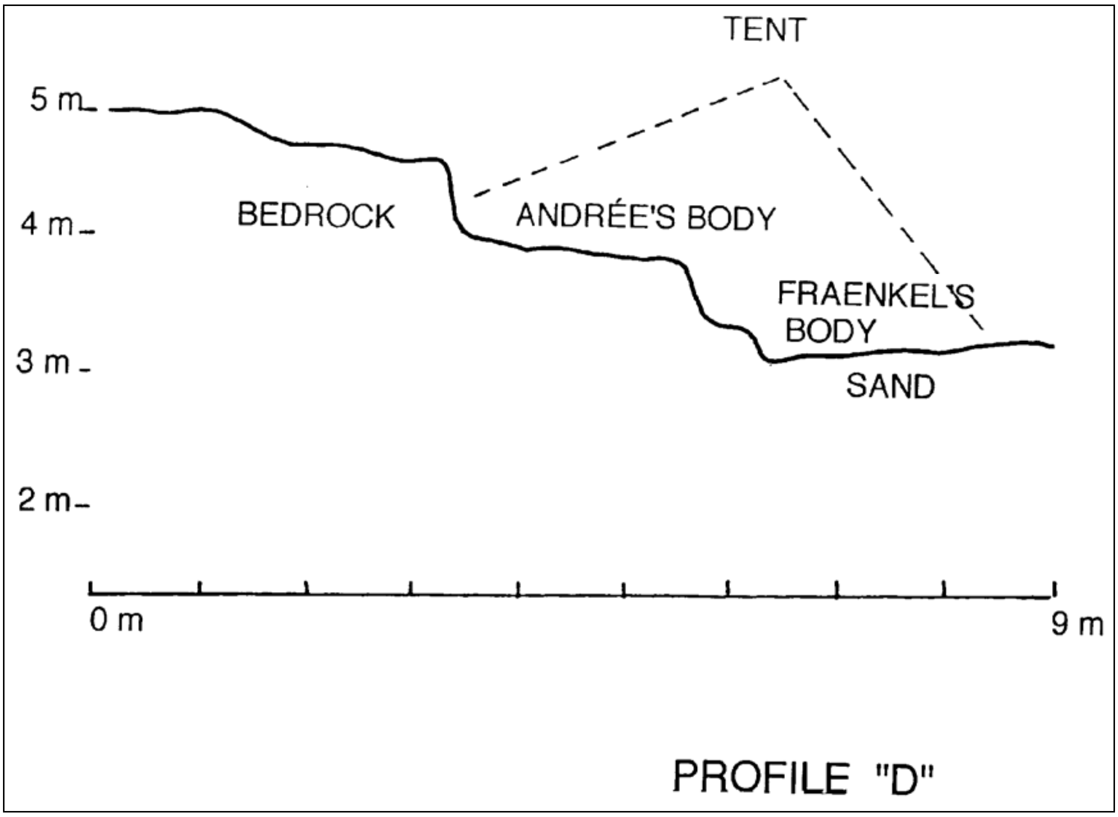

Figure 9. Surface profile D .The maximum extent of the hut is indicated. Using logs, the silk tent and polar bear skins, a strong structure could have been constructed. Remarkably, the hut would also have had naturally raised sleeping platforms. Map: Noel Broadbent.

Figure 10 Cans from the catalogue of the Memorial Exhibition at Liljevalchs konsthall (1931).

Metal detector mapping

A metal detector was used on the main site surface and adjacent areas and including the Strindberg grave. The general signals are shown by slashmarks superimposed on the map from 1930. There were numerous indications of metal at high and low sensitivity throughout the area of the tent and in the area where the sledges had been found. Two indications are indicated outside of these areas and near the wood piles. No signals were obtained from the Strindberg grave or near it. This mapping helps confirm the presence of secondary debris on the site conforming in large part with the sketch map from 1930 (Figure 11). The readings from the tent area are especially strong and may reveal larger objects embedded in the ice. The prevalence of opened cans shows that they were using this food while on the island.

Stray finds

Although most time was spent examining the camp surface, Sven Lundström of the Andrée museum found a food can some distance from the campsite, confirming that there is a larger dispersion of artifact material on the island. This could be due to original disposal in 1897 or through secondary dispersion by polar bears etc. In either case, it confirmed the need to carry out a greater survey of the area surrounding the camp.

Conclusions

This preliminary investigation of the Andrée campsite demonstrated that there were still archaeological materials visible on the site surface and preserved in the permafrost. The camp surface and layout are still discernable and should be fully mapped using a total surveying instrument. The site is better preserved than expected and should be documented using standard archaeological excavation and documentation. Complete photo documentation should be done at the site. Additionally, the complete exposure of the area surrounding the site allows for a widening of the investigation area. Food cans were found by Sven Lundström in 1998 and there could be more materials spread around the area.

There are considerable traces of wood, bone, cloth, hide and metal on the site. Many of the wood fragments emanate from the expedition. The bone can be both human and animal. The metal fragments derive from food cans, but there are also screws, wires and fittings of various kinds. Clothing is probably preserved in the frozen tent floor. These materials can be very useful for determining additional information about the expedition including a detailed assessment of camp use. Soil samples for phosphate mapping should be collected and results could shed light on the duration of site use.

It is likely that human bone can be found at the site and this material could be analyzed for heavy metal content etc. DNA could be used to determine if the bone is from one or two individuals (Fraenkel or Andrée) and possibly identify that individual through comparisons with living relatives.

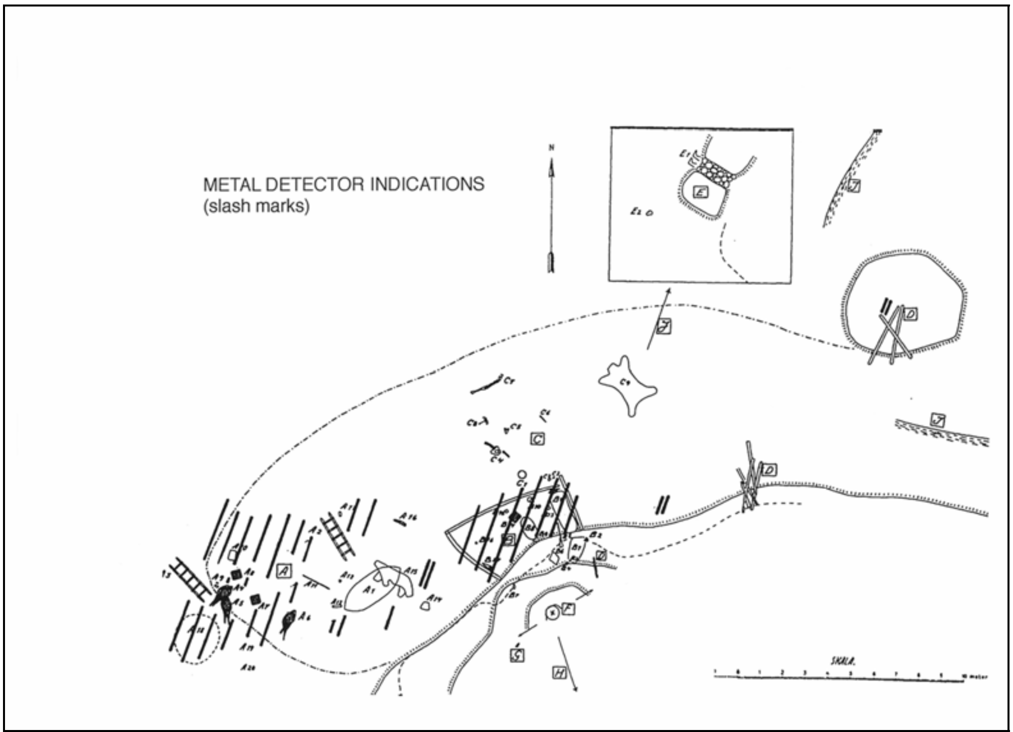

Figure 11. Map indicating readings using a metal detector superimposed on the find map from 1930. The signals correspond well with the tent area and Find Area "A" from 1930.

The final investigation of the Andrée site is especially urgent because of its exposure on light, sandy soils and the easy access to the site that warmer climate conditions have brought on. It is very likely that tourists will trample what is left of remaining site materials.

<u>Future planning (for 2000):</u>

1) It is recommended that a field project be organized to complete the archaeological documentation of the site. Fieldwork under normal conditions will require 7 - 10 days and 3 - 4 archaeologists.

2) It is recommended that the site be maintained and that a low fence be set up to prevent further disturbance of the surface. An interpretative sign with information about the site and expedition should be set up.

3) Following fieldwork, an analysis of finds materials, soil samples and in the case of human bone, DNA analysis should be carried out.

The main scientific questions are: 1) To assess the extent and duration of site use; 2) To assess the potential cause (s) of death.

The main management issues are: 1) To map the site and its artifact dispersals, and 2) To provide a baseline for future maintenance and protection of the site and to add to the historic awareness of the site as a cultural resource in the Arctic.

<u>The investigation plan</u>

The preliminary mapping and survey of the Andrée expedition camp in 1998 provided the incentive and rationale for further documentation of the site and its remains. Considerable traces of fibers, clothing, straps, cords, ropes, wooden and bamboo pieces, bone, metal fragments and small objects were visible on the site surface. A metal detector survey was carried out as well and compared with the sketch map that had been prepared by the site discoverers in 1930. Stray finds were also found some distance from the camp and a wider find survey was deemed necessary. Of special interest was the discovery that the tent floor was still frozen and clothing and other debris were embedded in ice.

The plan for 2000 encompassed detailed mapping and in *situ* photography of finds and features, soil prospection and sampling of deposits from the frozen core of the tent site. An overall objective was to produce an accurate map of the site as a foundation for site preservation and management. It is argued that the Andrée site, as well as many other similar historic places in Svalbard, is being impacted by tourism. The scientific investigation is based on several hypotheses:

1) Soil prospection can be used to test the hypothesis that Andrée and his two colleagues, Nils Strindberg and Knut Fraenkel, had survived in normal health on the island for some weeks or more. Soil phosphate, in particular, but also magnetic susceptibility, could reflect site use. It was also of interest to identify what, if any, kinds of activities or activity areas could be identified using soil chemistry. Did the men establish a toilet area, was there any evidence of burning or attempts at trash disposal? An additional scientific objective of this study was to obtain information about the basic chemistry of newly deglaciated soils and the imprints of human presence in this kind of terrain.

2) The hypothesis that the men died of, for example, botulism, rather than trichinosis, could be tested. Even finds of human bone could be used for analysis, including heavy metal traces and DNA. The recovery of frozen deposits, including soiled clothing, coprolites and seal meat, could be used to test for bacteria or toxins that could cast light on the cause of death of the three men. The focus of this attempt was the tent floor which had been shown to be frozen. A sampling trench in the tent floor would be required for this work.

3)) A recommendation that the site be better signed and protected was made, including the idea of a fence to keep people from treading directly on the campsite or pathways to lead people around the site was put forward.

These plans were submitted to Norwegian authorities and The Central Board of Antiquities in Oslo subsequently set the following conditions for the project (issued on May 5, 2000):

1) The main focus is to be put on the registration and documentation of the site and its surroundings.

2) The main tent area is not to be totally excavated.

3) Two test trenches, 20 x 100 cm, can be excavated. These cannot be extended through the center of the tent area but can intersect the wall lines.

4) Phosphate mapping can be carried out but the number of samples must be restricted in the area of the tent.

5) Placement of a fence around the site or the setting up of any signs is not permitted.

6) Following the study, the investigated areas must be restored to their original appearance.

7) Permission is granted for 2000. If the project is not completed a new permit must be requested.

8) In accordance with paragraph 12,2, the Royal Academy of Science shall cover all costs of conservation for any potential finds from the excavations.

9) In accordance with Paragraph 14,3, the report of the investigations, including maps must be sent to the Governor (*Sysselmannen*) with a copy to the Central Board within a year of the completion of the project.

FIELDWORK 2000

The *Origo* arrived at White Island at 1400 hours on August 29 after a c. 44 hour cruise from Longyearbyen. Our equipment had been sent north months earlier and was now transported ashore using zodiacs. A field tent was erected near the site to provide some protection from the wind and for storage. Unlike 1998 we quickly discovered that the area adjacent to the rock outcropping, where the majority of the site deposits were found, was now covered by a layer of ice, in some places more than 30 cm thick.

Figure 12 Ice cover on site, August 29. Annie Lindgren standing above the Andrée tent area (right). Johan Olofsson working with the total station (center), and David Loeffler, surveying (above left).Original wood pile as seen on Map, Figure 4 (left). Photo:Noel Broadbent.

Excavation

Using shovels, picks and iron bars, very much as the original discoverers had done in 1930, we were able to remove the thinner ice layers to within about 3 meters of the tent surface. The ice had melted free of the ground surface, which could thereby be exposed without disturbance. About 30 square meters were exposed and the ice chunks were piled some 10 meters away forming a considerable pile of ice debris. As we neared the rock shelf the ice became both thicker and more frozen to the ground surface. In addition, the heavy snows that came on the second day at White Island buried the site in deep drifts. Attempts were nevertheless made to extend two narrow trenches through the ice and up to the tent area. This effort proved fruitless, however, and the original plan for excavation in the tent area had to be abandoned. While no artifact materials were recovered, the ice trenches did make it possible to collect soil samples.

Figure 13 Snow cover on Andrée site, August 31. Two trenches being attempted down to ground level. The prism rod is positioned directly on the elevation datum point. Photo: Lyder Marstrander.

Digital mapping

The Constructor (Spectra Precision) instrument was used to digitally map the site area. Maps based on these data are shown here for both the site area and the soil survey. The data also make it possible to build a three dimensional model of the site which is being produced by the Andrée Museum. Luckily, the immediate area of the tent, covered by ice in 2000, had been mapped in 1998 (Figure 7). Using a previously established datum point marked by a steel pin near the tip of the rock outcropping and having an elevation of 5.39 meters above sea level, we set up our surveying equipment and carried out mapping over the next three days. Our laser "total station" could record 2500 elevations and coordinates per day in all directions and distances up to 1500m. Using this instrument we were able to map the entire site surface area down to the shore (Figure 14). Work on the map continued until September 1.

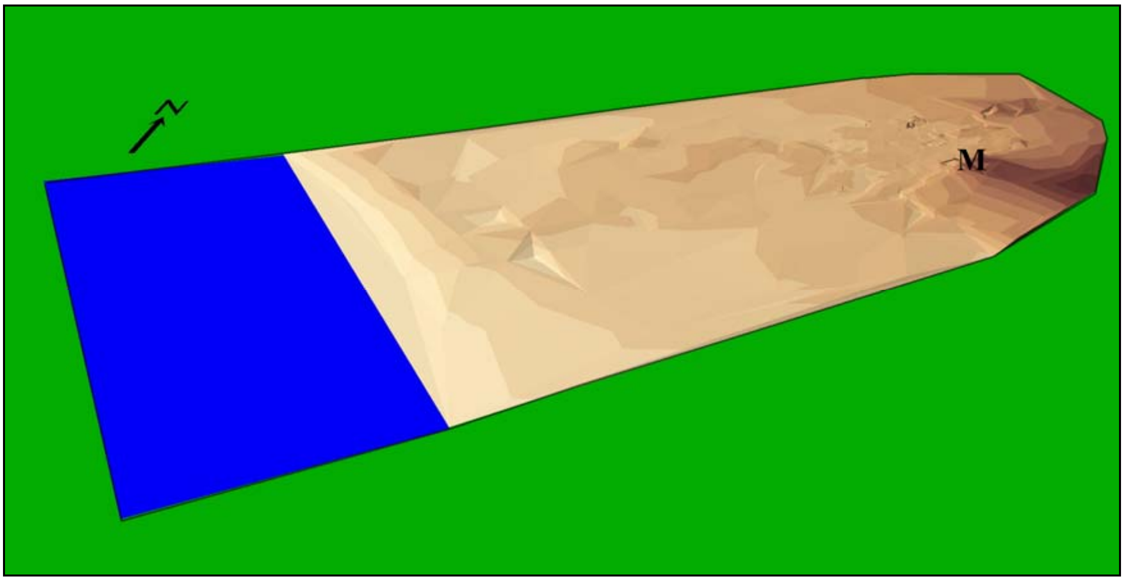

Figure 14. A three dimensional "aerial" view of the site. (The Andrée monument is marked with a "M" and the tent area is marked with a brown square below the monument). Map: Johan Olofsson.

Soil prospection

Johan Olofsson, from the Environmental Archaeology Laboratory in Umeå, and the team members carried out the soil survey. Using hand tools, 240 soil samples were collected in transect lines on and around the campsite. A detailed description of this work is given separately in this report. The snow cover did not hamper this work and the removal of ice facilitated sampling near the tent area. Collection of samples resulted in minimal disturbance of the site surface and the small sampling depressions were refilled.

Find survey

The area around the site, extending 175 meters down to the shore and a kilometer to the ice edge, could not be surveyed for artifacts as planned. In spite of this, two remarkable new finds turned up. While standing polar bear watch, one of the Polar Research Secretariat's field experts, Jan Johansson, found a bone which appears to be a human middle tarsal bone (or seal bone ?) (Figure 15). Located on a rise behind the camp it could be a bone from Andrée or Fraenkel whose bodies were badly damaged and scattered by polar bears. This bone may indicate that there are more traces of human remains to be found around the site. As noted in 1998, a bone splinter was found on the rock shelf near the place where Andrées body had been found. But, it is possible that much of the bone is from a later date and deposited by polar bears There were many indications that polar bears had recently slept on the site.

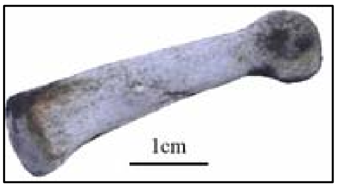

Figure 15 Bone found near the Andrée camp.

The second artifact was found some 350 meters to the southeast of the campsite by the Nova film team. Two fragments of a wooden harness used to pull the sleds were found, evidently discarded where they broke in October 1897 (Figure 16). Two identical harnesses are on display at the Andrée Museum. This find suggests that this is where the group came ashore on White Island and that the camp site was carefully chosen after they had surveyed the area.

Figure 16 Fragments of a wooden harness found southeast of the campsite.

These finds were photographed and left *in situ.* While there was some discussion about recovering these items, it was decided the conditions seriously hampered the analysis of context and that they were better left where they were found. The intention of detailed mapping of these and related finds could not be undertaken due to snow cover.

Figure 17 The location of the broken harness (foreground) and the campsite in the distance.(Looking NW). Photo: Noel Broadbent.

Photography

Two 35mm cameras were to be used for site documentation. But, as in the case of excavation, the weather and ice conditions seriously hampered this effort. The black and white and color photographs which were taken in 1998 and 2000 are kept at the Department of Archaeology and Saami Studies at Umeå University.

Conclusions

The fieldwork in 2000 could not live up to our expectations. In spite of the appalling weather and ice conditions, a soil prospection of the site could be carried out and a three-dimensional map was created. The scientific and management potentials of the site were reaffirmed. It could be concluded that an excellent snow and ice free campsite had been located and that heavy building materials had been assembled for the construction of a winter hut. The rock shelf provided natural sleeping platforms. This, in turn, suggests that the men were in good physical and mental condition on arrival to White Island. The find of a broken sled harness suggests where the group came ashore, c. 350 meters to the southeast of the camp (Figure 17). As will be argued in the presentation of the soil chemical analysis, there is no indication that the men were alive for much more than a few weeks after arrival.

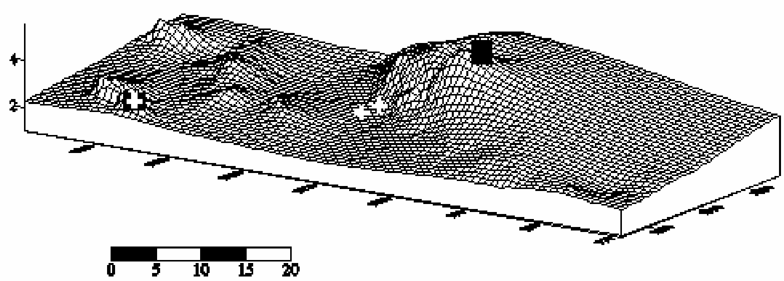

Figure 18 Three dimensional close-up of the Andrée site. Crosses indicate location of bodies. Black rectangle, the monument. Map: Noel Broadbent.

ENVIRONMENTAL ARCHAEOLOGY AT ANDRÉENÄSET

Andréenäset is situated on very desolate seashore at White Island (Figure 3). The island is about 40 kilometres long and 20 kilometres wide and the better part is covered with ice. The glacier reaches 400 metres above sea level. Topography at Andréenäset is quite flat with a lot of bedrock (Figure 19). The soil consists of sandy gravel moraine. White Island is regarded as a polar desert (Elvebakk, 1997). Before undertaking the survey an investigation plan was formulated (appendix B).

The aims of the investigation based on soil chemical studies are twofold:

1. Estimation of length of site use based on soil chemical analysis.

2. If estimated time is relatively long, a reconstruction of the camp (areas used for disposal of waste material, slaughtering etc) can be undertaken.

An additional aspect of this investigation is the nature of the site itself. It could be regarded as analogous to an environment that Late Post.glacial/Mesolithic humans (9000-4200 BC) would have experienced had they visited areas near glaciers. A small group of Stone Age hunters slaughtering animals and preparing food could be a comparable event to what happened at Andréenäset. The results could be used for better interpretations of prehistoric sites.

Theoretical assumptions

1. In an environment like this almost all organic and phosphate containing material were brought to the site by man or beast.

2. If the men stayed for a longer period, they would have had to bring meat to the camp.

3. The human body process 1-2 g of phosphorus a day (Devlin 1986). In a certain volume of soil this means that there will be an enrichment of phosphate compounds induced by man.

4. Phosphate enrichment can be assumed to be greater closer to the site centre (tent area) and decline further away.

The amount of phosphate compounds measured has an analytical error of about 5 %. This means that any sample analysed must differ from another sample with more than 5 % in order to be regarded as a different level. With the method at hand (phosphate compounds in soil extracted by citric acid and spectroscopic determination of a phosphorous-molybdate complex), it is difficult to get around this problem without substantially modifying the method. As a consequence, there is no way to separate samples into a finer graded scale. The overall conclusions must necessarily consider larger time scales of survival, that is a “short time” or a “long time”. The present methods make it difficult to consider shorter time frames, for example less than a few weeks.

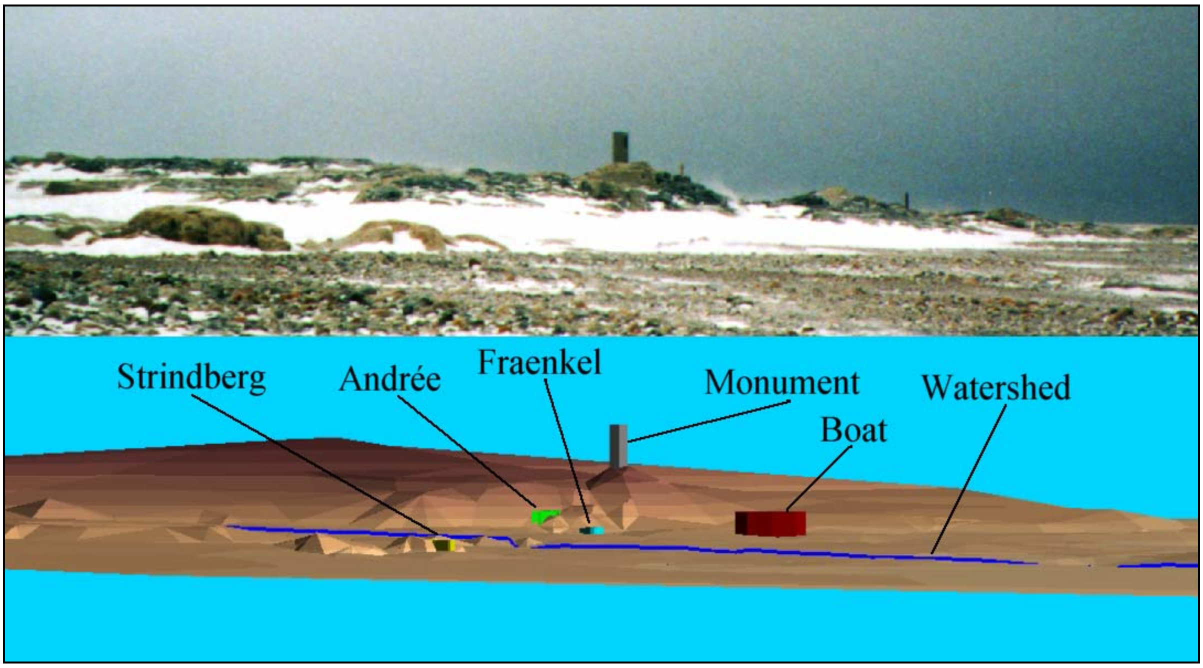

Figure 19 Andréenäset as present and as reconstruction. Photo and map: Johan Olofsson.

Material and methods

The soil samples, once collected, are analysed for phosphate content, organic content and other parameters. These parameters are commonly used in modern archaeology to characterise and interpret ancient settlements.

<u>Sampling strategy</u>

The strategy was to sample two areas. The first area is defined as the space used for activities like slaughtering animals, disposal of garbage, defecation and so on. The area should be large enough to enclose much of the activities the men carried out. This area is, of course, also affected by natural disturbances, e.g. polar bear activity, vegetation and geology. This area will be called “the Camp Area” or “CA”. The main part of the camp area was available for sampling. Due to ice cover important areas, e.g. near the remains of the tent floor, were nearly impossible to sample.

The second area is defined as an area virtually undisturbed by human activities. Any wildlife contributions should be the same as in CA. This area will be called “the control sample area” or “CS”.

In the field situation the size of the separate areas were determined. The Camp Area was expected to be 0,2 ha and the control sample area was set to 0,8 ha. The grounds for these decisions were mainly based upon the map from 1930 (Figure 4). Natural demarcations, e.g. rock and topography were also used to delimit sampling areas (Figure 20).

Sampling depth was defined by thawing depth. It varied between 3 and 11 cm, which means that all samples were quite superficial. In similar regions thawing depth could be as great as 40 cm (Chernov och Matveyeva, 1997) but this expectation was not met.

As there are no higher soil living organisms in this environment (Elvebakk, 1997), basically every movement through soil profile should be caused by cryoturbation or fluid water. If cryoturbation is very active in this area some of the remains from 1895 probably has been moved downwards and cannot be detected in this survey. Cryoturbation easily moves stones and can redistribute soil matter (Viklander 1997). Due to shortage of time no measures were taken to estimate the extent of cryoturbation.

Analytical methods

Several parameters were analysed. Some have direct consequences for meeting the goals of the survey (P^o, Ptot, LOI, MS) whilst others are used for general description and understanding of the site (grain size, pH, conductivity, MS550).

The following parameters were used:

Phosphate analysis, P^o (Citric acid method based on the method of Arrhenius and modified by the Environmental Archaeology Laboratory). Phosphate content is defined as mg P_2O_5/100 g dry soil extracted with citric acid (2 %).

Phosphate analysis after oxidative combustion, **Ptot**. Phosphate content is defined as mg P_2O_5/100 g dry soil extracted with citric acid (2 %) after oxidative combustion at 550°C for 3 h (Engelmark and Linderholm, 1996).

Organic content, LOI (%) estimated trough combustion of sample at 550°C for 3 h. Content is defined as percent of dry sample.

Magnetic susceptibility, MS (dimensionless, SI units) measured on a Bartington MS2 (with a MS2B measure cell). Susceptibility is defined per 10 g of soil (Thomson and Oldfield, 1986).

Magnetic susceptibility after oxidative combustion at 550°C, MS550 (dimensionless, SI units) measured on a Bartington MS2 (with a MS2B measure cell). Susceptibility is defined per 10 g of soil (Thomson and Oldfield, 1986).

Grain size quota was determined by weighing two fractions of a sub sample; one fraction containing grains smaller than 2 mm and one fraction larger than 2 mm. The fraction smaller than 2 mm was divided by the fraction larger than 2mm (Grain size quota = < 2mm / > 2mm).

pH was measured on a Mettler MP225 pH meter with 3 point calibration. 10 ± 0,2 of soil was mixed with 20 ml distilled water for 30 minutes. The soil was left 30 minutes to sediment before decanting and measurement.

Conductivity was measured on a Mettler MC 226 Conductivity meter. Same samples as for pH were used. Conductivity is defined as µS/cm.

Before any analysis (except pH and conductivity) sub samples are dried at room temperature. Then dry sub samples are sieved through a 2 mm mesh. Occurrence of carbonised wood, bone, shell, iron fragments etc. are noted.

Results

Soil chemical analysis

A total of 240 soil samples were analysed (Figure 21). CA contains 209 soil samples and CS contains 31. A statistical description of the results is shown in Table 2.

In general pH value at Andréenäset is 8. Conductivity in the soil is 74 ± 21 (n = 12). Organic content (LOI) varies between 0,2 and 4,0 %, mean value is 0,6 ± 0,5 %. The value of pH and Conductivity is expected in this kind of environment (Stonehouse 1989). The soil matter is but to a small extent chemical weathered and vegetation is almost non-existent except for some algae, lichens and mosses.

Camp Area (CA)

The mean of phosphate enrichment is 17 ± 9 P^o (n=209). Maximum value is 38 and minimum is 2. The sample is normal distributed (Figure 22).

The mean of MS value is 5 ± 4 SI. Maximum value is 40 and minimum is non-detectable. Distribution within sample is normal (Figure 23). The maximum value of 40 can be explained by occurrence of rusty flakes in sample (see lab.note, MALno. 0_0118:0195, Table 3). This sample is to be regarded as an outlier.

Control sample area (CS)

The mean of phosphate enrichment is 11 ± 11 P^o (n=31). Maximum value is 38 and minimum is 1. Distribution within sample is not clear (Figure 22).

The mean of MS value is 4 ± 2 SI. Maximum value is 8 and minimum is 0. Distribution within sample is normal (Figure 23).

Statistics

In order to compare the two samples (CA and CS) two methods were used. Firstly, the samples were compared through a boxplot (Figure 24).

Secondly, comparison of the means was used. Calculating the t value (equations are shown in Figure 31) shows that there are a significant difference between the two samples to a confidence interval of 95 % (0). The null hypothesis is rejected for MS and P^o, but retained for LOI.

The CA sample was downsized from 209 to 30 in order to get a sample with similar spatial representation as the sample containing control material. Breaking down the sample into 7 groups and recalculating the t value results in 2 groups retaining the null hypothesis for P^o and 5 where it has to be rejected. The null hypothesis for MS and LOI has to be rejected in all cases.

Spatial distribution

Relatively high levels of phosphate enrichment can be seen in northern part of survey area (Figure 25). Some enrichment can also be seen in southern part. This pattern also occurs in MS (Figure 26) and LOI (Figure 27) data.

Grain size

Grain size seems to be correlated to height above sea level (Figure 28). The proportion of courser material is higher in lower areas. Sub samples with courser material coincide with the watercourse.

Remains of shells

The amount of shell-remains was estimated through ocular examination in the laboratory. The soil samples were divided into three groups: "contains nothing", "contains some" and "contains several". The amount shell-remains seem to be correlated to the watercourse. Close to it the quantity is fewer compared to surrounding areas (Figure 29).

Concluding remarks on the results

An explanation for the relatively high levels of analysed parameters in the northern part of the survey area could be the result of an old dried up water furrow. Since water is an important biological growth factor, a local microenvironment could be formed in puddles, which would speed up biological activity (Stonehouse, 1989). Growth of bacteria will concentrate nutrients and microbiological activity can change magnetic susceptibility of iron compounds (Thomson and Oldfield, 1986). The formed concentrations of nutrients could then be a substrate for higher organisms like lichens and mosses.

Grain size distribution and amount of shell-remains are also consistent with this conclusion. Figure 30 shows clearly that higher levels of organic content and low amount of shell-remains is separated from fine-coursed soil matter and higher amount of shell-remains.

Discussion of environmental data

The data suggests that there is a significant difference between the areas CA and CS. But the difference is probably caused by natural causes, and not by human activities. Water flow through the area (precipitation and melting) has probably a greater influence as a soil forming process with direct consequences for soil matter composition.

This conclusion is supported by the fact that a higher level of different parameters (phosphate, MS, LOI) coincide with the watercourse. When a watercourse changes direction it will alter the shape of the surface, the structure of the soil and its composition.

Some element of error lies in the estimation of Camp area size. A smaller or larger area could change the statistics to some extent, but probably not alter the conclusion.

Another possible error is if e.g. cryoturbation is very strong and not equally distributed over the site, then this would most certainly cause soil chemical data to be tilted, that is, the distribution maps may be altered.

To answer the question about how long Andrée, Frænkel and Strindberg survived on White Island one must regard all data presented. Doing so, one conclusion is that they cannot have survived for more than one month, probably less. A survival for half a year or more would probably contaminate the camp area to greater extent, especially around the tent and in the open plain in front of the tent facing the sea. This conclusion is consistent with other known fact e.g. the absence of hearths. Linked to the amount of driftwood found on the site and the fact that the primus kitchen still contained kerosene (Andrée et al. 1930), suggests that they had fuel for making fire but there was no need for it.

Last note written by the men is Strindberg writing "Hem kl 7,5 fm" (Home 7:30 am) on the 17th of October, 12 days after arriving on White Island. This was probably written a short time before the expedition reached its ultimate end.

Figure 20. Sampling points and topography at Andréenäset. Sampling points are marked with spots, the watercourse is marked with a line and the monument is marked with a small gray colored square. Other features are objects found on the site in 1930. North is to the left. Map: Johan Olofsson.

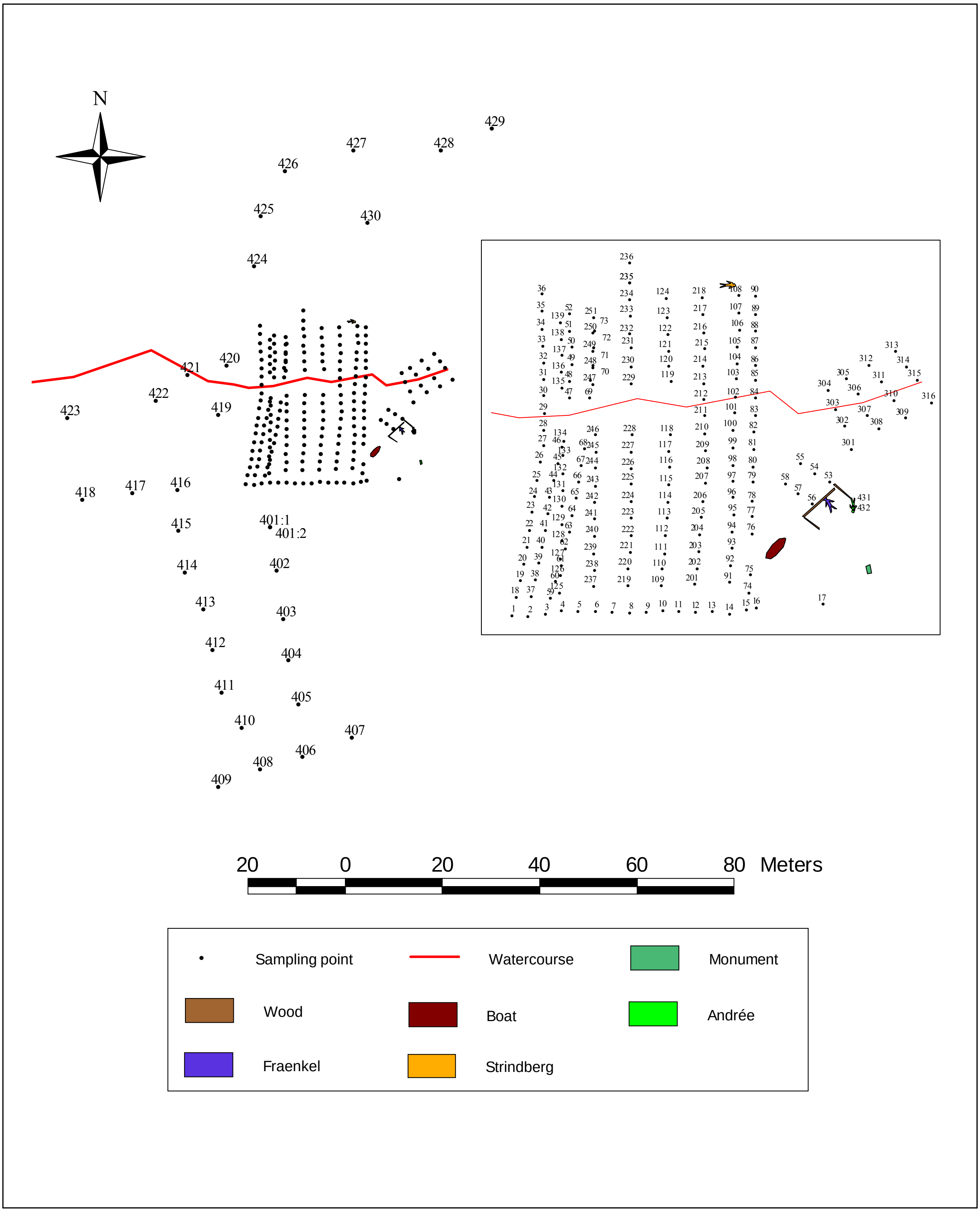

Figure 21. Sampling points at Andréenäset. Map: Johan Olofsson.

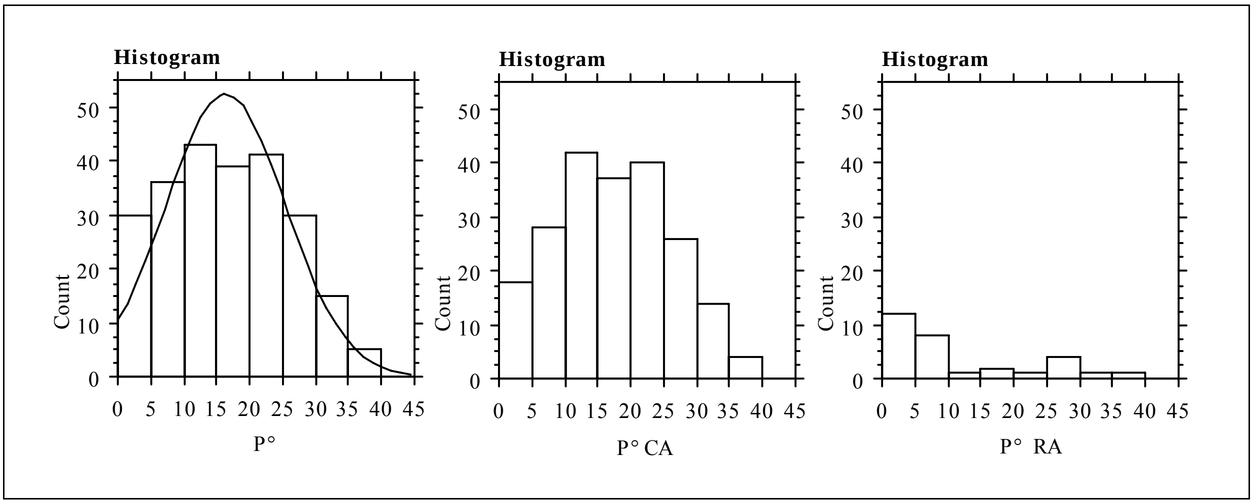

Figure 22. Histogram of the phosphate content (Po) in both areas, in Camp area (CA) and in Control sample area (CS) respectively.

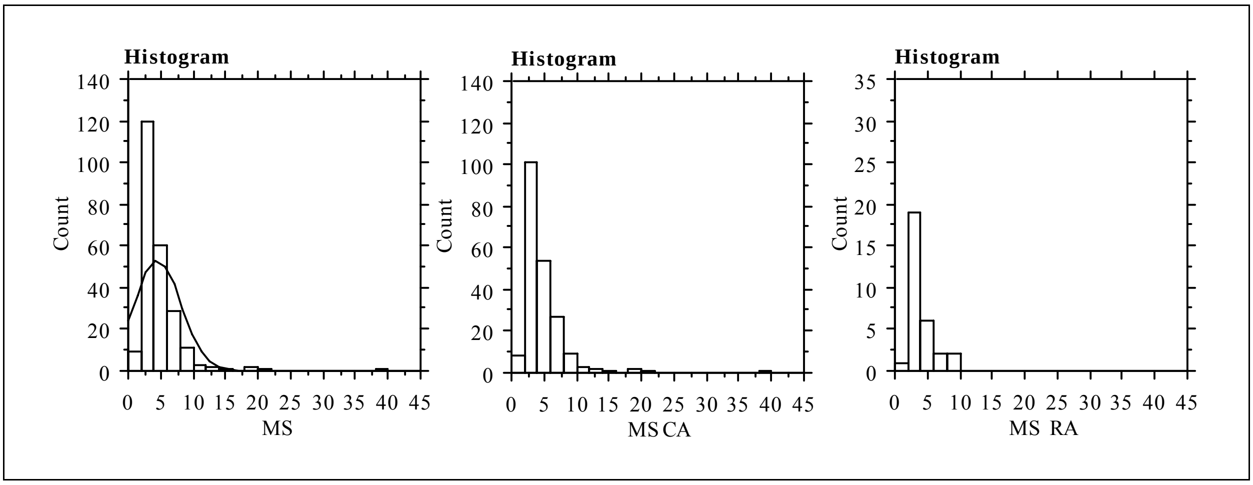

Figure 23. Histogram of Magnetic susceptibility (MS) in both areas, in Camp area (CA) and in Control sample area (CS) respectively. (Please note the difference in scale on the y axis.)

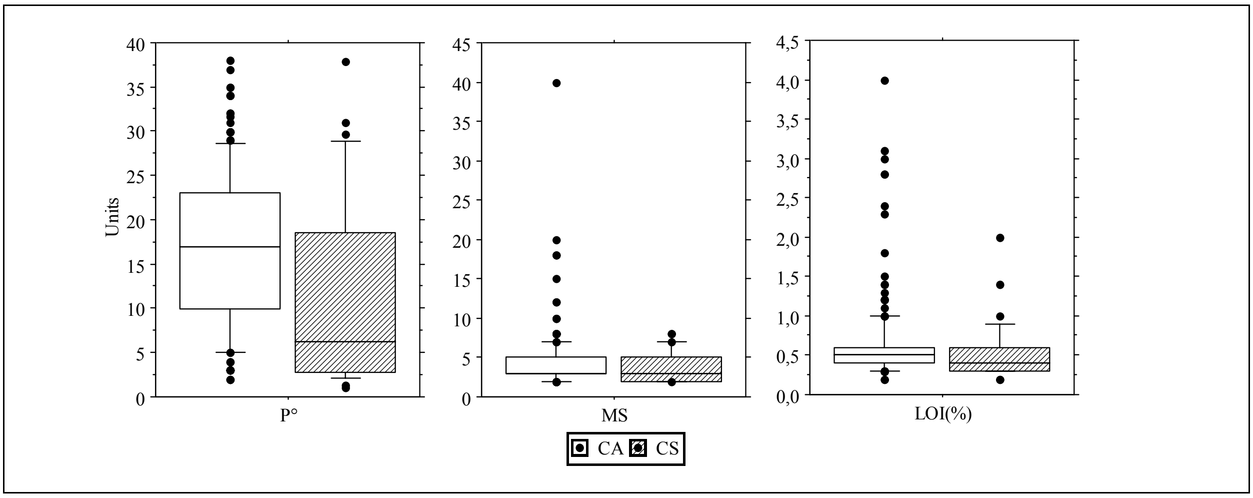

Figure 24. Box plots showing each sample, Camp area (CA) (n = 209) and Control sample area (CS) (n = 31) for three parameters (phosphate content, magnetic susceptibility and organic content (LOI)).

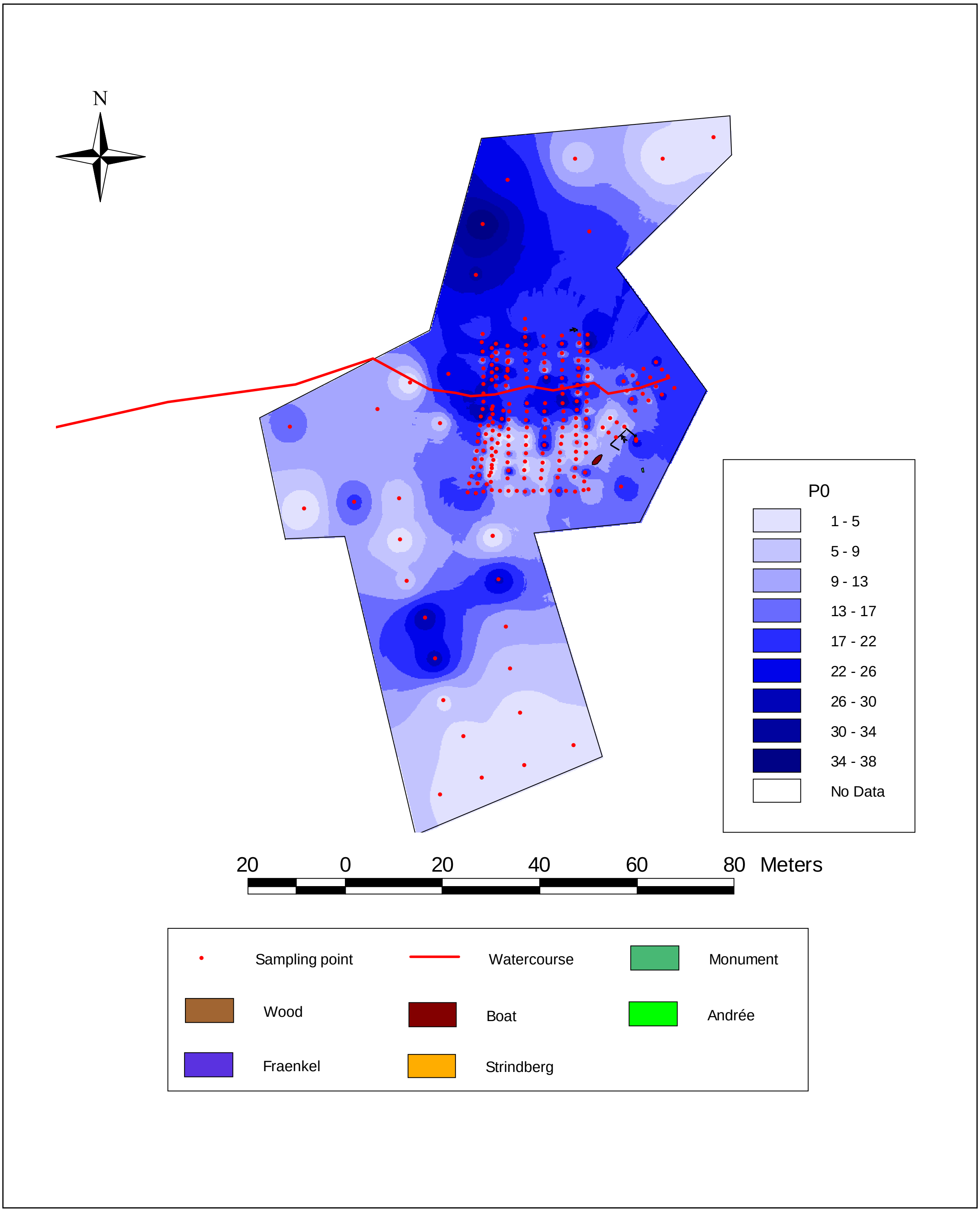

Figure 25. Soil chemical map, distribution of phosphate enrichment (P^o). The map shows there are low concentrations in the immediate camp area, suggesting a short use period. High concentrations correspond with natural drainage patterns. Map: Johan Olofsson.

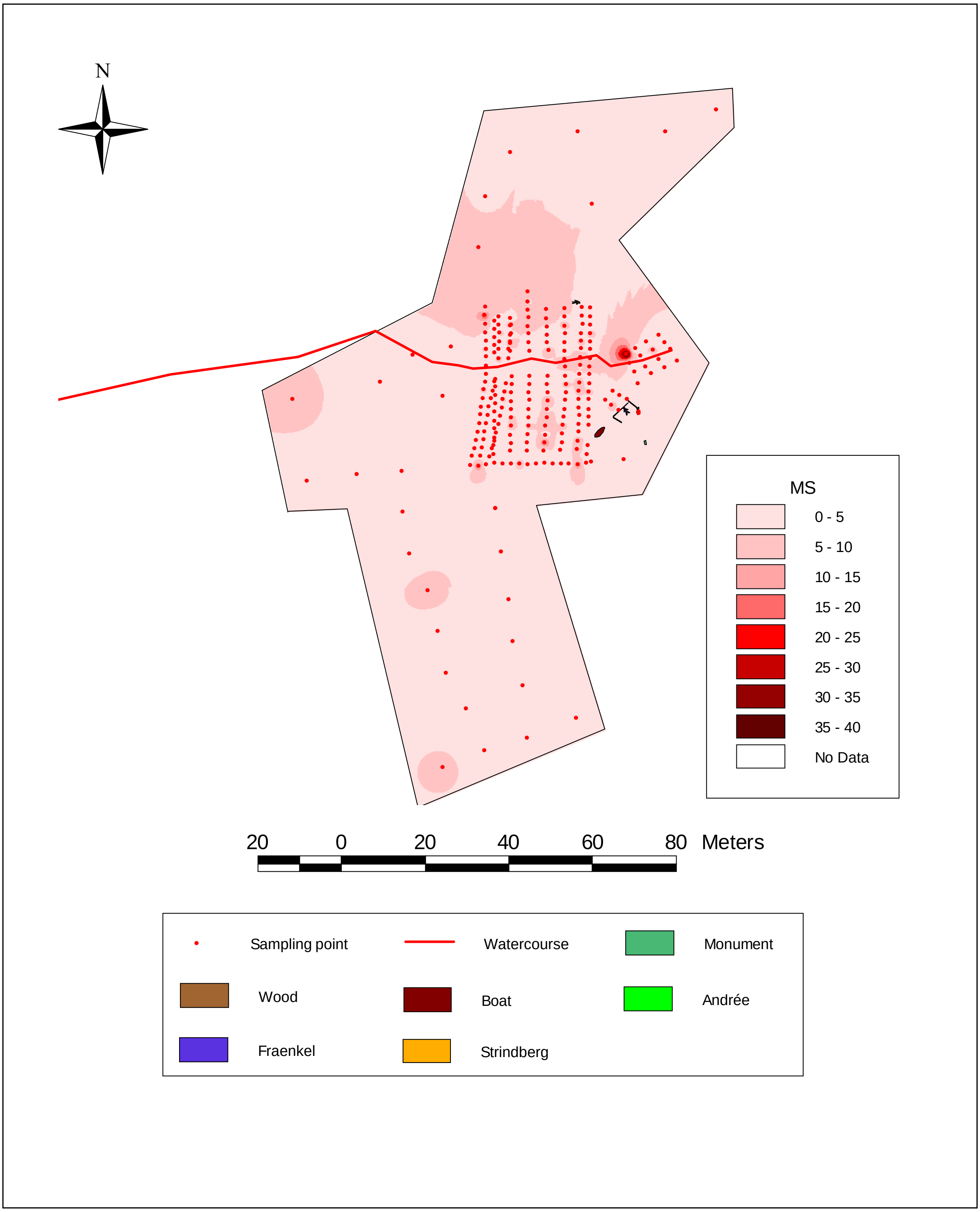

Figure 26. Soil chemical map, distribution of magnetic susceptibility. The single isolated concentration to the north of the campsite is due to rusty metal fragment.. Map: Johan Olofsson.

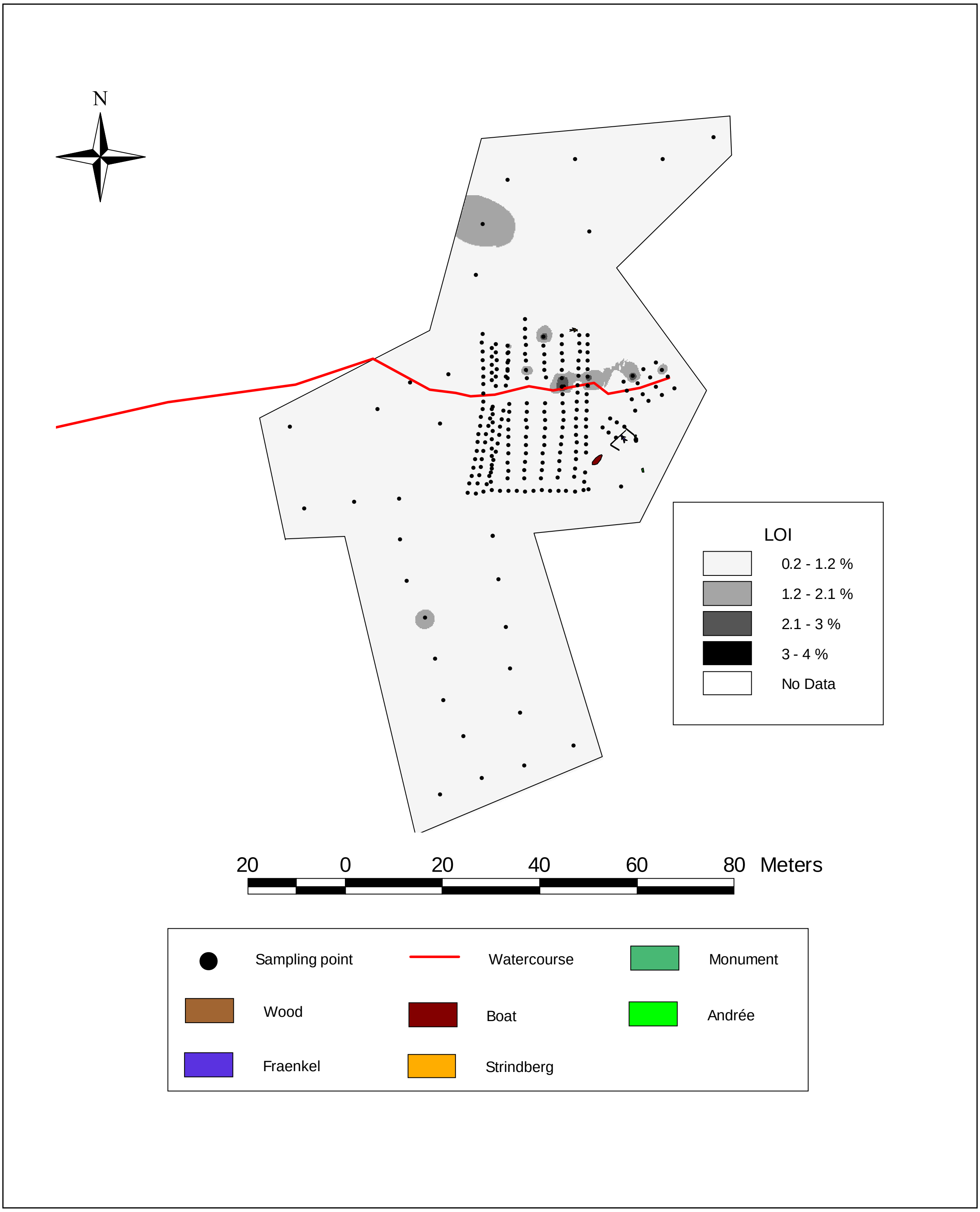

Figure 27. Soil chemical map, organic content, LOI (%). Map shows generally low values. Higher values probably correspond with natural drainage. Map: Johan Olofsson.

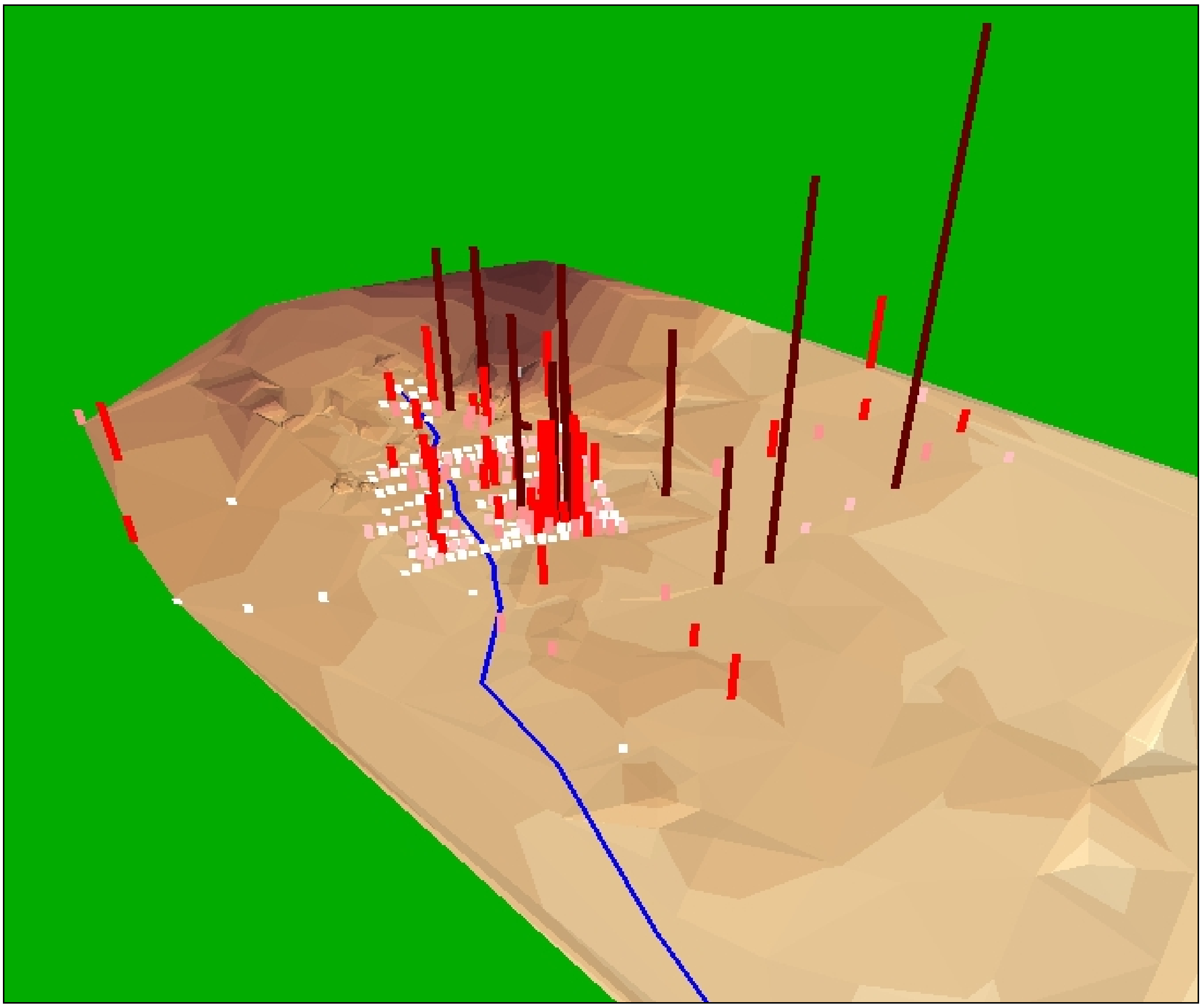

Figure 28. Grain size distribution at Andréenäset. Grain size is defined as "fraction < 2 mm divided by fraction > 2 mm". Bigger proportions of fine grained soil is marked darker red and with a higher pin. The watercourse is marked blue and the monument is grey. Map: Johan Olofsson.

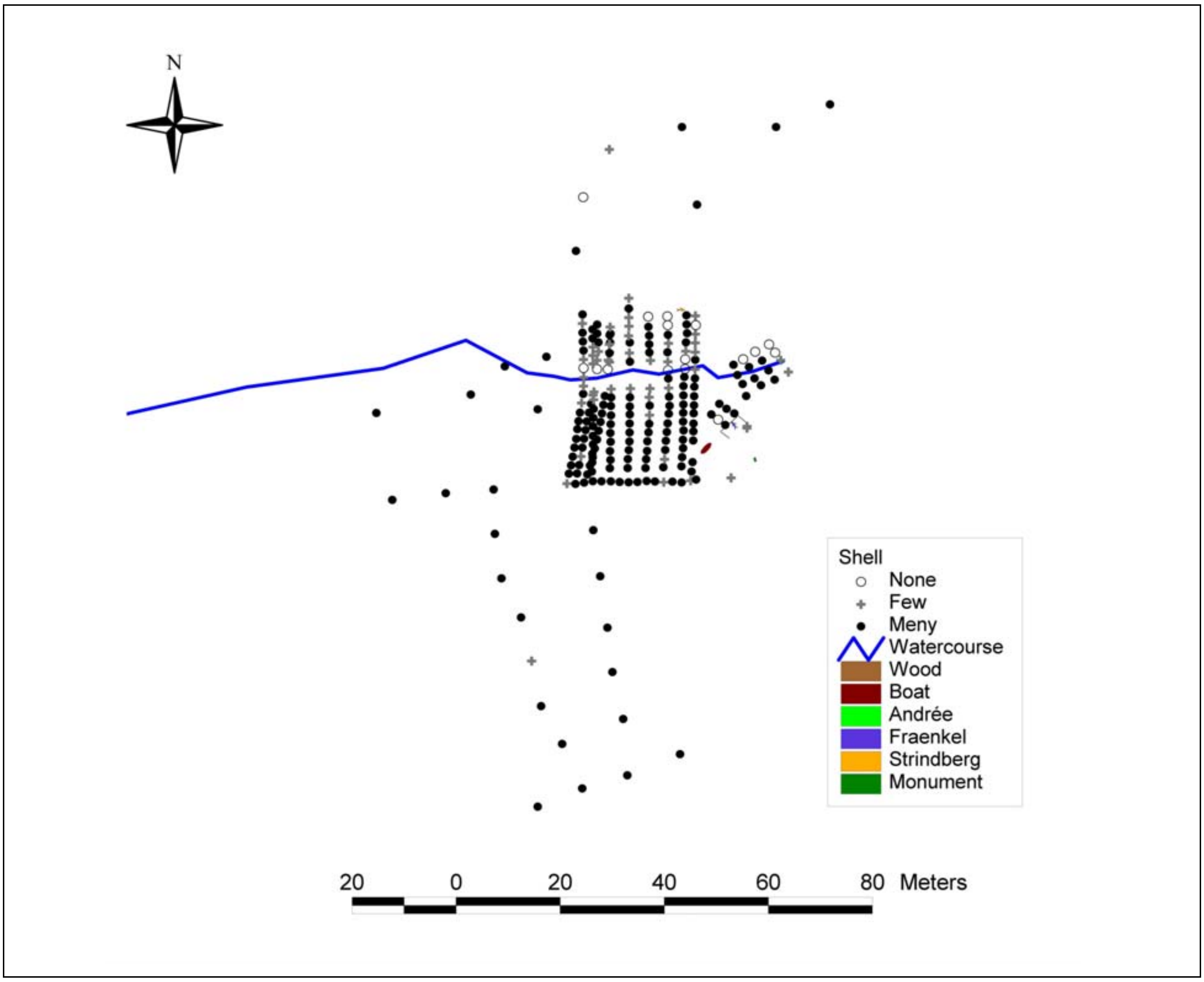

Figure 29. Distribution of shell-remains. Map: Johan Olofsson.

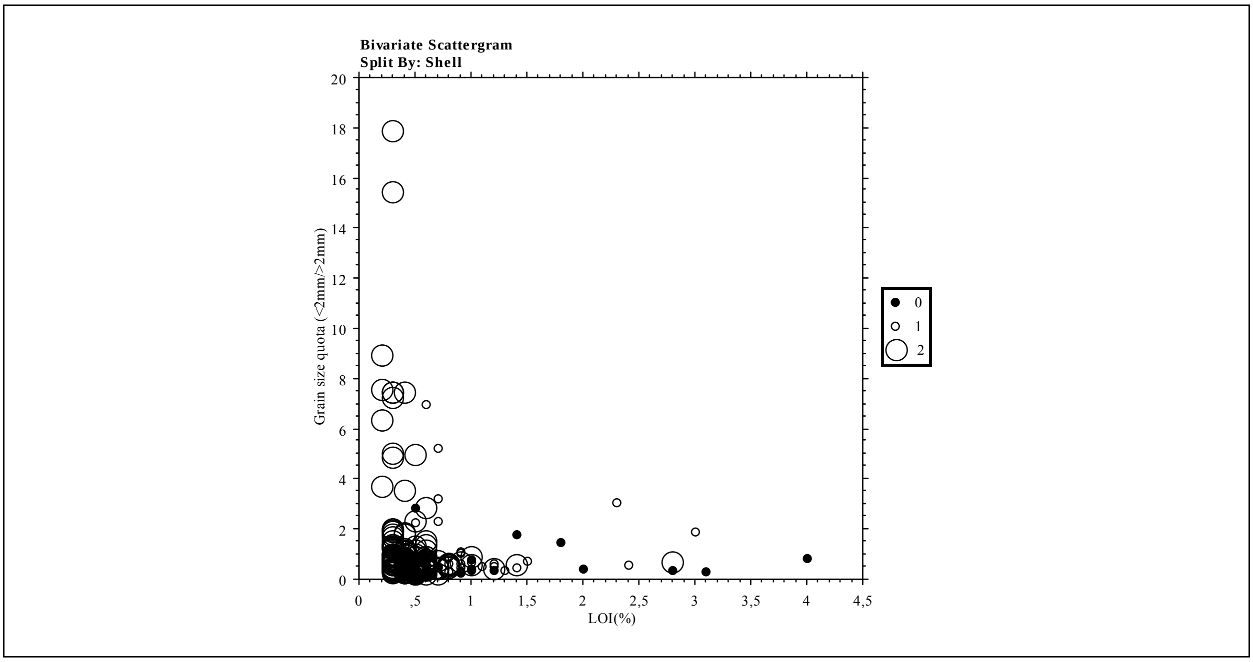

Figure 30. Comparison between grain size quota (= < 2mm / > 2mm) and organic content (LOI), split by presence of shell. 0 equals absence of shell, 1 equals low amount of shells and 2 equals a high amount of shells.

SUMMARY AND CONCLUSIONS

The archaeological investigation of the Andrée site rendered much new and valuable information. The site has now been accurately mapped and a soil prospection study has been carried out. The premise that more finds are to be found in and around the site was proven correct. Soil prospection has confirmed that the site was occupied for a relatively short period of time. The diary notations indicate only twelve days and the phosphate and magnetic susceptibility measurements do not contradict this. It is likely, judging from the locations of the bodies, that all three men died within some hours of each other. This gives credence to the theory that the three men died of poisoning and would also explain the lack of notations in their journals. This theory still demands the excavation of the Andrée tent floor and the recovery of organic samples for the testing of toxins.

The find of a broken sled harness to the southeast of the camp suggests that the men came ashore some distance (c 350 m) from the campsite and devoted much energy to locating a suitable place for the erection of a winter dwelling. They transported their equipment to this site and collected heavy logs which were to be used for constructing a dwelling with natural bedrock sleeping platforms. This suggests they were initially in good physical and mental condition on arrival to the island. A comparison between site surfaces in 1998 and 2000 implies that the camp site was ice and snow free when established in 1897. This campsite was well chosen and would have provided good conditions for survival.

The Andrée site investigation has opened the door to a series of new questions regarding research and site management of historic sites in the high latitudes. Archaeological and environmental archaeological analysis should be implemented to a greater extent in the future. New aspects of the Andrée site will require follow up studies. This includes the completion of the excavation proposal and a mapping project for find materials from the wider area surrounding the site. Each site of this type has a peripheral area many times the size of the campsite itself. The soil prospection study has shown there are no simple answers as to how a site of this type was used or the nature of the chemical fingerprints left behind. Much more basic research is required to fully understand the chemistry of northern sites. Finally, protection of these sites must be seen as the key to preserving the information potential of the past. Without strict measures, they will be lost to both science and the public in a matter of decades.

Recommendations for Future Research and Management

The Andrée site represents a growing problem in the Arctic: the impacts of tourism on the fragile Arctic environment. Although very isolated, this site is visited every year by numerous tourists. On our arrival on August 29 we could see literally hundreds of human footprints in the sandy soil. Visitors inadvertently walk all over the most sensitive surfaces, possibly with great respect, but also doing damage to the delicate site surfaces. Many objects have been removed over the years (which is illegal), and many more casually picked up and taken out of *situ*. Visitors have recently attempted to erect permanent unauthorized markers on the site. It is for precisely these reasons that new efforts must be put into the documentation of historic sites in the Arctic, accompanied by more information and suitable pathways on the sites, as well as continued monitoring. These sites are nonrenewable historic resources bearing witness to human exploration, courage and tragedy. They deserve our full attention, respect and protection. They need to be preserved to educate and inspire future generations of arctic visitors.

LITERATURE

Andrée, S.A., Strindberg, Nils & Fraenkel, Knut. 1930. *Med Örnen mot polen*. Sällskapet för antropologi och geografi. Stockholm.

Broadbent, N. D 1998. *Report on a preliminary archaeological investigation of the Andrée expedition camp on White Island, Spitsbergen. 1998 "Lance" Expedition of the Swedish Program for Social Science Research in the Polar Regions, August 16-24, 1998*. Dept. of Archaeology, University of Umeå. (Manuscript).

Broadbent, N. D. 2000. Archaeological fieldwork at Andréenäset, Vitön, Spitsbergen – a preliminary report. *Swedarctic 2000.*. Stockholm. pp.62-64

Broadbent, N. D. 2000. Expedition Vitön i Andrées spår. *Populär arkeolog*. nr. 4, 2000. pp. 19-22.

Capelotti, P. J. 1997. *The Wellman Polar Airship Expeditions at Virgohamna, Danskøya, Svalbard*. Norsk Polarinstitutt Meddelelser no. 110 Oslo.

Capelotti, P. J. 1999. Virgohamna and the Archaeology of Failure. *The Centennial of S.A. Andrée's North Pole Expedition*. (U. Wråkberg, ed.). Stockholm. pp. 30-43

Chernov, Y.. I, Matveyeva, N. V. 1997. Arctic Ecosystems in Russia. *Ecosystems of the World. Polar and AlpineTundra, nr. 3*.(Wielgolaski, F.E., ed.). Elsevier science. B.V. Amsterdam.

Devlin, T. M. ed. 1986. *Textbook of Biochemistry with Chemical Correlations*. 2nd edition. Wiley. New York.

Elvebakk, A.. 1997. Tundra Diversity and Ecological Characteristics of Svalbard. *Ecosystems of the World. Polar and Alpine Tundra, nr. 3*. (Wielgolaski, F.E., ed.) Elsevier science. B.V. Amsterdam.

Engelmark, R; Linderholm, J. 1996. *Prehistoric land management and cultivation. A soil chemical study*. Proceedings from the 6th Nordic Conference on the Application of Scientific Methods in Archaeology, Esbjerg 19-23 September 1993.AREM 1. Esbjerg.

Fynden på Vitön. Minnesutställning över S. A. Andrée, Nils Strindberg och Knut Fraenkel anordnad i Liljevalchs konsthall. 1931. Liljevalchs konsthall, katalog nr. 90. Stockholm.

Kjellström, R. 1999. *Andrée-expeditionens och dess undergång—tolkningar nu och då*. The Centennial of S.A. Andrée's North Pole Expedition. (U. Wråkberg, ed.). Stockholm. pp. 34-55.

Lithberg, N. 1930. The Campsite on White Island and Its Equipment. In: Andrée, S.A., Strindberg, Nils & Fraenkel, Knut. 1930. *Med Örnen mot polen*. Sällskapet för antropologi och geografi. Stockholm. pp. 189-227.

Lundström, S.. 1997. "*Vår position är ej synnerligen god....Andrée expeditionen i svart och vitt*." Stockholm.

Miller, J.C., Miller, J.N. 1993. *Statistics for Analytical Chemistry*. 3rd ed. Analytical Chemistry Series. Chichester. England.

Personne, M. 2000. Andrée-expeditionens män dog troligen av botulism. *Läkartidningen*. vol. 97. nr 12. pp. 1427-1431.

Stonehouse, B. 1989. *Polar Ecology*. Blackie. Chapman and Hall. USA.

Thomson, R; Oldfield, F. 1986. *Environmental Magnetism*. London.

Viklander, P. 1997. *Compaction and Thaw Deformation of Frozen Soil, Permeability and Structural Effects due to Freezing and Thawing*. Luleå University of Technology, Luleå, Sweden.

Wråkberg, Urban (ed.). 1999. *The Centennial of S.A. Andrée's North Pole Expedition*. Royal Swedish Academy of Sciences. Stockholm.

ABBREVIATIONS AND DEFINITIONS

P° = Phosphate content, defined as mg P_2O_5/100 g dry soil extracted with citric acid (2 %). Citric acid method based on the method of Arrhenius and modified by the Environmental archaeology laboratory.

Ptot = Phosphate content after oxidative combustion. Phosphate content is defined as mg P_2O_5/100 g dry soil extracted with citric acid (2 %) after oxidative combustion at 550°C for 3 h (Engelmark and Linderholm, 1996).

Pquota = Ptot / P^o

LOI = Loss on ignition (%), estimated trough combustion of sub sample at 550°C for 3 h. Content is defined as percent of dry sub sample.

MS = magnetic susceptibilitet (dimensionless) measured on a Bartington MS2 (with a MS2B measure device). Susceptibility is defined per 10 g of soil (SI) (Thomson and Oldfield, 1986).

MS550 = Magnetic susceptibility after oxidative combustion at 550°C (dimensionless) measured on a Bartington MS2 (with a MS2B measure device). Susceptibility is defined per 10 g of soil (SI) (Thomson and Oldfield, 1986).

CA = Camp area.

CS = Control sample area.

Appendix A: Investigation plan for environmental archaeology (in Swedish)

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2000-02-10

Miljöarkeologisk undersökningsplan för Andréenäset, Vitön, Svalbard

1. Inledning

Andrée, Strindberg och Frænkel steg iland på Vitön den 5 oktober 1897 efter en dramatisk färd på ett isflak. Man övernattade troligen på stranden till 7:e för att sedan göra en omflyttning av lägret ett hundratal meter högre upp. Den sista anteckningen som görs är Strindberg som den 17 oktober antecknar ”Hem kl. 7,5 fm” i sin almanacka. Man spekulerar i att männen mellan den 7:e och den 17:e genomförde rekognoseringar på ön (Andrée et al, 1930).
Strindberg dog sannolikt först av de tre. Han blev begravd till skillnad från de två andra. Men hur länge lyckades Andrée och Frænkel överleva?

Syftet med undersökningen är dels att dokumentera de lämningar som ännu finns bevarade på Andréenäset, dels att försöka uppskatta den tidsrymd 1897 års expeditionsdeltagare uppehöll livhanken på platsen.
Den miljöarkeologiska undersökningen kommer i huvudsak att koncentreras till frågeställningen som rör hur länge de tre männen kunde överleva på ön. Den metod som skulle kunna användas för att göra denna undersökning är markkemisk prospektering.

2. Förutsättningar

Tre förutsättningar måste uppfyllas för att denna dela av projektet skall lyckas.

1. Det måste finnas material att samla in från relevanta delar av lägerplatsen.
2. Marken måste ha tinat tillräckligt mycket så att prover kan tas.
3. Då det saknas empiri från liknande undersökningar, måste det finnas en teoretisk grund för at anta att det finnas några möjligheter att lösa problemet med markkemiska analyser.

Förutsättning 1. Jordarten är i delar av området, enligt tidigare besök på platsen, finsandigt grus (Broadbent, 1998), vilket är en jordart som rent tekniskt är mycket lätt att provta.

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Förutsättning 2. I denna polaröken kan permafrosten smälta till ett djup av 40 cm (Chernov och Matveyeva, 1997) vilket i så fall skulle vara tillräckligt. Erfarenheterna från den senaste expeditionen till ön gör det rimligt att anta att en väsentlig del av ytan kommer att vara isfri under sensommaren 2000.

Förutsättning 3. Vitöns sydvästra udde tillhör den arktiska polaröknen (Elvebakk, 1997). Karaktäristiskt för denna naturtyp är artfattigdom, liten nederbörd och låg temperatur. Det finns en del högre växter men i huvudsak består floran av lavar och mossor, vilka kan täcka 20 % av en yta i ett område (Elvebakk, 1997). Få rötter tränger djupare än 10-15 cm (Chernov och Matveyeva, 1997).
Undersökningar gjorda på destruenter i denna biotop är begränsade, men består huvudsakligen av bakterier, svampar och mikroevertebrater. Makroevertebrater som t.ex. maskar och snäckor saknas helt (Elvebakk, 1997).

Detta visar sammantaget att nedbrytningshastigheten sannolikt är mycket låg. Vi kan inte förvänta oss att organiskt material har omsatts i marken i någon större utsträckning. Matrester, fekalier etc. kan ligga förhållandevis ytligt och endast till viss del vara nedbrutet. Emellertid avger människan ca. 1 g fosfor (P) per dygn (Devlin, 1986). Om man antar att ytan för lägerplatsen är 30 x 10 meter och att den avgivna mängden fosfor (P) blandas in i den översta decimetern jord kommer teoretiskt sett tre män att under 14 dagar anrika jorden med 0,07 mg P per 100 g jord. Det är ett mycket litet värde som med svårighet kan kvantifieras.
Om däremot tidsrymden närmar sig ett halvt år blir anrikningen enligt samma uträkning istället 0,9 mg P, d.v.s. ett 10 gånger högre värde och möjligheten till kvantifiering betydligt större. Om man där till lägger bidraget från övrig fosfatanrikning t.ex. slaktavfall ökar sannolikt nivån ytterliggare.
En förutsättning för att denna halt skall gå att detektera är att bakgrundsvärdet, d.v.s. fosfathaltens naturliga nivå är mycket låg samt att den naturliga variationen inte är för stor. Att samla in jämförande kontrollprov blir avgörande för att kunna utvärdera data.

I det fall vi finner en signifikant variation i de markkemiska parametrarna kommer vi dessutom att göra ett försök till markanvändningsanalys. Markanvändningsanalysen kan beskriva hur de organiserade sitt läger, främst hur de hanterade sitt avfall.

3. Genomförande

Ansvarig för den markkemiska prospekteringen är personal från Miljöarkeologiska laboratoriet (MAL).
Det tänkta undersökningsområdet är omkring 100 x 100 meter. Provtagningen kommer att utgå ifrån de ca 10 x 30 meter som utgör lägerplatsens centrum och sträcka sig ut från denna yta (se 0).
Prover kommer att samlas in med jordsond (se 0 och 0). Cirka 1 deciliter kommer att samlas från varje provpunkt. Hålet blir ungefär 5 cm i diameter och maximalt 30 cm djupt. Den jord som inte överförs till provpåse återförs till provhålet. Spår efter ingreppet kommer att raderas ut genom att hålet fyllas igen i direkt anslutning till provtagningen.
Om jorden är mycket torr finns en risk att jordsonden inte fungerar (provet fastnar inte i sondens kanna) I så fall kommer en liten spade av den typ man använder i trädgårdar att användas. Hålet blir med nödvändighet större, möjligen 1x1 dm.
På den centrala ytan bör prover samlas var annan meter. I det perifera området kan prover var tionde till tjugonde meter anses vara tillräckligt. I var tionde provpunkt, jämt fördelade över ytan, kommer prover att insamlas i flera nivåer för att vi på så sätt skall få uppfattning om hur markkemin varierar med djupet i denna marktyp. Man kan anta att det förekommer en

omflyttning av jordmaterial i marken som beror på frysning och smältning (Viklander, 1997). Större stenar trycks upp mot ytan vilket medför att finare material kan föras nedåt i profilen. Omfattningen av denna effekt bör studeras för att man skall kunna göra rimliga tolkningar av data.
Till detta kommer ett tiotal referensprover att insamlas i liknande marktyp väl utanför det förmodade aktivitetsområdet (ett hundratal meter). Totalt kommer cirka 160 stycken prover att insamlas. Denna beräkning utgår ifrån att det är tekniskt möjligt att samla prover jämnt över hela ytan.
Varje provpunkt markeras på en fältkarta samt mäts in med totalstation.

Stor varsamhet invid Andrée-expeditionens fysiska lämningar kommer att iakttagas. Inga synliga strukturer kommer att störas. Provpunkternas placering kommer att anpassa till fysiska lämningar och geologiska förhållanden.

Den viktigaste markkemiska parametern vi avser att använda är fosfathalt, men också organisk halt samt magnetisk susceptibilitet är viktiga. De används alla inom arkeologisk forskning för att karaktärisera boplatser. Dessa parametrar kan ge antydningar om omfattningen av aktiviteter i ett område, både ytmässigt och tidsmässigt. Fosfatanrikning sker när t.ex. slaktavfall, fekalier m.m. bryts ned och omsätts i marken. Bestämning av organisk halt kan på ett kompletterande sätt visa på mängden tillfört material till jorden. Magnetisk susceptibilitet (ett materials magnetiserbarhet) är kopplat till eldningsaktiviteter, men också bakteriell aktivitet (Thomson och Oldfield, 1986). På förhistoriska boplatser ser vi ofta en förhöjning i dessa parametrar.

Varje prov vill vi analysera med avseende på fem parametrar:
1. Fosfatanalys, **P°** (fosfatgrader) enligt Arrhenius och Miljöarkeologiska laboratoriets citronsyrametod. Fosfathalten anges som mg P_2O_5/100 g torr jord extraherad med citronsyra (2%).
2. Fosfatanalys efter oxidativ förbränning, **Ptot** (fosfatgrader). Fosfathalten anges som mg P_2O_5/100 g torr jord extraherad med citronsyra (2%) efter förbränning av provet vid 550°C (Engelmark och Linderholm, 1996).
3. Organisk halt, **LOI** (%) bestämd genom förbränning av provet vid 550°C i 3 timmar. Halten anges i procent av torrt prov.
4. Magnetisk susceptibilitet, **MS** (dimensionslös) bestämd på en Bartington MS2 med en MS2B mätcell. Susceptibiliteten anges per 10 g jord (Thomson och Oldfield, 1986). Med MS menas magnetiserbarheten hos ett material, dvs. i vilken omfattning ett jordprov förstärker ett pålagt magnetiskt fält.
5. Magnetisk susceptibilitet efter oxidativ förbränning vid 550°C, **MS550** (dimensionslös) bestämd på en Bartington MS2 med en MS2B mätcell. Susceptibiliteten anges per 10 g jord (Thomson och Oldfield, 1986).

Samtliga analyser kommer att utföras på MAL.

4. Slutkommentar

5.

Vi kan med våra metoder inte göra en exakt tidsbestämning med hjälp av dessa parametrar, utan tidsbestämningen kan endast göras i termer av kort tid respektive lång tid. Kort tid motsvaras av låga värden i de analyserade parametrarna och lång tid skulle motsvaras av högre värden. Vad som kan anses vara höga respektive låga värden avgörs vid jämförelse med prover från mark som kan anses vara ostörd.

5. Kostnad

Provanalyser, markkemi: 160 stycken prover á 182 = 29120:- (exklusive moms, inklusive avgift till Umeå universitet). Analyskostnader för markkemiska prover avser analys av fem parametrar (angivna ovan).

Referenser

Andrée, S. A.,Strindberg, N., Frænkel, K. 1930. Med Örnen mot polen. Sällskapet för antropologi och geografi. Stockholm.
Broadbent, N. D. 1998.Report on a Preliminary Archaeological Investigation of the Andrée ExpeditionC on White Island. Dept. of Archaeology, University of Umeå.
Chernov, Yu. I, Matveyeva, N. V. 1997. Arctic Eecosystems in Russia. Ecosystems of the world. Polar and alpine tundra. Wielgolaski, F.E. Elsevier science B.V. Amsterdam.
Devlin, T. M. ed. 1986. Textbook of Biochemistry with Chemical Correlations. 2nd edition.

Elvebakk, A.. 1997. Tundra Diversity and Ecological Characteristics of Svalbard. Ecosystems of the World. Polar and Alpine Tundra. Wielgolaski, F.E. Elsevier science B.V. Amsterdam.
Engelmark, R; Linderholm, J. 1996. *Prehistoric land management and cultivation. A soil chemical study.* Proceedings from the 6th Nordic Conferens on the application of Scientific Methods in Archaeology, Esbjerg 19-23 September 1993.AREM 1. Esbjerg.
Thomson, R; Oldfield, F. 1986. *Environmental Magnetism*. London.
Viklander, P. 1997. Compaction and Thaw Deformation of Frozen Soil, Permeability and Structural Effects due to Freezing and Thawing. Luleå University of Technology, Luleå, Sweden.

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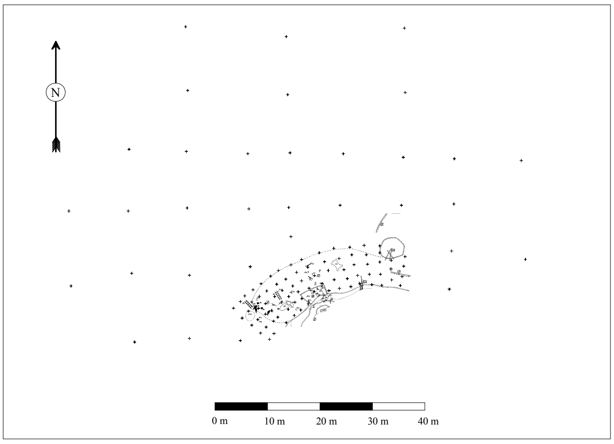

Figur 1. Provpunkternas ungefärliga fördelning i terrängen på Andrée näset förhållande tilldе funna lämningarna (+ = provpunkt). Kartan över Andrée expeditionens läger är hämtad ur Andrée et al, 1930.

Figur 2. Bild på hur jordsonden är tänkt att användas.

Figur 3. *Närbild på jordsonden*

Appendix B: Soil chemical data

$$t = \left(\overline{x_1} - \overline{x_2}\right) / \sqrt{\left(s_1^2 / n_1 + s_2^2 / n_2\right)} \qquad (1.1)$$

$$\text{degrees of freedom} = \left\{ \frac{\left(s_1^2 / n_1 + s_2^2 / n_2\right)^2}{\frac{\left(s_1^2 / n_1\right)^2}{n_1 + 1} + \frac{\left(s_2^2 / n_2\right)^2}{n_2 + 1}} \right\} - 2 \qquad (1.2)$$

Figure 31. Equations used for calculating t value (Miller and Miller 1993).

Table 1. Comparison of the means of Camp area (CA) and Control sample (CS). Parameters marked grey indicates that the null hypothesis has to be rejected.

	MS CA	MS550 CA	LOI(%) CA	P° CA	Ptot CA	Pkvot CA	pH CA	µS CA
Mean	5	14	0,6	17	17	1,2	8	70
Standard deviation	4	7	0,5	9	9	0,9	0	16
(Standard deviation)^2	14	47	0,3	74	83	0,8	0	268
n	209	209	209	209	209	209	7	7
Max	40	99	4	38	72	8	8	95
Min	0	6	0	2	3	0	8	54

	MS CS	MS550 CS	LOI(%) CS	P° CS	Ptot CS	Pkvot CS	pH CS	µS CS
Mean	4	9	0,5	11	11	1,7	8	81
Standard deviation	2	5	0,4	11	10	1,9	1	27
(Standard deviation)^2	4	21	0,1	122	95	3,6	0	702
n	31	31	31	31	31	31	5	5
Max	8	25	2	38	36	11	9	126
Min	0	2	0	1	3	0	8	60

t	2,4	5,4	1,4	2,8	2,8	-1,5	-1,1	-2,3
Degrees of freedom =	73	55	50	36	39	32	34	34
Critical values of t (confidence interval 95%)	1,96	2,01	2,01	2,04	2,04	2,04	2,04	2,04

Table 2. Descriptive statistics, calculated on Camp area (CA) and Control sample (CS) as one sample.

	MS	MS550	LOI(%)	P°	Ptot	Pkvot	pH	µS
Mean	4,5	13,0	,6	16,4	15,9	1,2	8,1	74,3
Std. Dev.	3,6	6,8	,5	9,1	9,3	1,1	,4	20,9
Count	239	239	239	239	239	239	12	12
Minimum	0,0	2,0	,2	1,0	2,6	,2	7,5	53,7
Maximum	40,0	99,0	4,0	38,0	72,3	10,8	8,8	126,2

Table 3. Results from soil chemical analysis, Andréenäset.

MALno.	Field no.	Area	X (N)	Y	Z	Sampling depth	Lab. note	MS	MS550	LOI(%)	P°	Ptot	Pquota	pH	µS	Shell	Grain size quota <2mm/>2mm
0_0118:0001	1	CA	997,48	1952,09	2,33			2	16	0,8	18	19	1,1			1	0,7
0_0118:0002	2	CA	997,37	1954,00	2,28		Flakes plastic/metal?	18	18	0,6	24	28	1,2			2	0,4
0_0118:0003	3	CA	997,64	1955,95	2,32			3	12	0,7	21	27	1,3			2	0,5
0_0118:0004	4	CA	997,98	1957,86	2,38			3	12	0,3	13	21	1,6			2	0,6
0_0118:0005	5	CA	997,92	1959,80	2,35			3	12	0,3	10	14	1,4			2	0,4
0_0118:0006	6	CA	997,94	1961,88	2,35			5	12	0,4	4	7	1,7			2	0,6
0_0118:0007	7	CA	997,78	1963,87	2,30			8	16	0,5	12	21	1,8			2	0,4
0_0118:0008	8	CA	997,73	1965,89	2,20			2	8	0,3	16	19	1,2			2	1,9
0_0118:0009	9	CA	997,79	1967,86	2,28		Plant?	3	12	0,5	14	11	0,8			2	1,0
0_0118:0010	10	CA	998,01	1969,89	2,37	7cm		5	18	0,4	5	8	1,7			2	0,6
0_0118:0011	11	CA	997,89	1971,77	2,36	4 cm		3	12	0,6	14	20	1,4			2	1,4
0_0118:0012	12	CA	997,81	1973,75	2,43	3 cm	Wood	5	12	0,8	23	14	0,6			1	0,9
0_0118:0013	13	CA	997,88	1975,66	2,53	8 cm		3	10	0,4	14	8	0,5			2	1,2
0_0118:0014	14	CA	997,67	1977,73	2,57			15	12	0,6	16	8	0,5			2	0,7
0_0118:0015	15	CA	998,12	1979,71	2,50			2	12	0,7	11	15	1,4			1	2,3
0_0118:0016	16	CA	998,32	1980,95	2,56	6 cm	Iron (rust)	2	8	0,3	10	12	1,2			2	7,4
0_0118:0017	17	CA	998,77	1988,76	3,48			5	12	0,7	20	20	1,0			1	3,2
0_0118:0018	18	CA	999,66	1952,53	2,35	6 cm		2	12	0,4	15	8	0,5	8,29	94,7	2	0,8
0_0118:0019	19	CA	1001,51	1953,05	2,33			2	12	0,4	18	14	0,8			2	0,8
0_0118:0020	20	CA	1003,46	1953,40	2,34	9 cm		2	10	0,3	12	8	0,7			2	1,3
0_0118:0021	21	CA	1005,50	1953,79	2,35	9 cm		3	14	0,4	19	10	0,5			2	1,0
0_0118:0022	22	CA	1007,46	1954,19	2,32	7 cm		2	16	0,5	11	24	2,2			2	0,4
0_0118:0023	23	CA	1009,63	1954,43	2,33	6 cm		5	14	0,4	24	19	0,8			2	0,3
0_0118:0024	24	CA	1011,41	1954,70	2,37			5	14	0,5	25	21	0,9			2	0,5
0_0118:0025	25	CA	1013,34	1955,02	2,42	8 cm		3	14	0,6	17	10	0,6			2	0,5
0_0118:0026	26	CA	1015,55	1955,35	2,28	8 cm		7	14	0,5	37	25	0,7			1	0,4
0_0118:0027	27	CA	1017,51	1955,74	1,98			5	14	0,3	32	30	0,9			2	0,5
0_0118:0028	28	CA	1019,30	1955,80	2,04			3	14	0,4	22	25	1,1			1	0,3
0_0118:0029	29	CA	1021,27	1955,84	1,98			5	12	0,4	29	16	0,5			1	0,5
0_0118:0030	30	CA	1023,31	1955,79	2,25			3	14	0,5	29	21	0,7			0	0,3
0_0118:0031	31	CA	1025,28	1955,80	2,24			7	16	1,4	21	26	1,2			1	0,5
0_0118:0032	32	CA	1027,24	1955,79	2,27	10 cm	Plant remains	5	12	0,7	20	15	0,8			2	0,5
0_0118:0033	33	CA	1029,24	1955,65	2,32			5	12	0,8	11	12	1,1			2	0,6
0_0118:0034	34	CA	1031,22	1955,57	2,30			10	18	0,6	29	21	0,7			2	0,6
0_0118:0035	35	CA	1033,33	1955,54	2,22			20	42	0,7	27	28	1,0			1	0,5
0_0118:0036	36	CA	1035,32	1955,58	2,08			5	12	0,6	17	32	1,9			2	0,2
0_0118:0037	37	CA	999,69	1954,37	2,24			5	14	0,4	15	17	1,1	8,37	55,1	2	0,5
0_0118:0038	38	CA	1001,59	1954,84	2,28			3	12	0,3	25	28	1,1			2	0,7
0_0118:0039	39	CA	1003,57	1955,21	2,30			0	12	0,4	19	19	1,0			1	0,7
0_0118:0040	40	CA	1005,49	1955,54	2,41			3	16	0,6	9	27	3,0			2	0,5
0_0118:0041	41	CA	1007,48	1955,92	2,37			2	14	0,5	22	27	1,2			2	0,5
0_0118:0042	42	CA	1009,42	1956,25	2,35	9 cm		0	8	0,3	14	3	0,2			2	0,9
0_0118:0043	43	CA	1011,36	1956,52	2,32			0	8	0,4	3	13	4,4			2	1,8
0_0118:0044	44	CA	1013,33	1957,02	2,31			2	10	0,4	13	6	0,4			2	0,6
0_0118:0045	45	CA	1015,30	1957,48	2,31			5	12	0,6	19	25	1,3			2	0,5
0_0118:0046	46	CA	1017,32	1957,90	2,26			2	12	0,5	27	23	0,8			1	0,3
0_0118:0047	47	CA	1023,09	1958,81	2,24			7	18	1	21	25	1,2			0	0,3
0_0118:0048	48	CA	1025,10	1958,80	2,40			3	16	0,4	19	19	1,0			1	0,4
0_0118:0049	49	CA	1027,06	1959,13	2,32			3	16	1,3	35	37	1,1			1	0,3
0_0118:0050	50	CA	1029,09	1959,15	2,35			7	14	0,6	21	10	0,5			2	0,6
0_0118:0051	51	CA	1031,04	1958,85	2,43	4 cm		5	20	0,9	12	21	1,8			2	0,7
0_0118:0052	52	CA	1033,04	1958,86	2,36			5	16	1,2	30	24	0,8			2	0,4
0_0118:0053	53	CA	1013,15	1989,49	2,75	6cm		3	10	0,4	6	16	2,6			2	1,1
0_0118:0054	54	CA	1014,20	1987,77	2,74			5	12	0,3	13	6	0,5	8,39	60,3	2	0,8
0_0118:0055	55	CA	1015,30	1986,16	2,66			5	10	0,4	3	5	1,6			2	0,8
0_0118:0056	56	CA	1010,56	1987,49	2,65			5	12	0,6	12	17	1,4			2	0,9
0_0118:0057	57	CA	1011,78	1985,87	2,65			8	16	0,5	13	20	1,5			0	2,9
0_0118:0058	58	CA	1012,93	1984,34	2,67			0	8	0,4	3	3	1,1			2	0,8
0_0118:0059	59	CA	999,48	1956,65	2,28			2	12	0,4	21	6	0,3			2	0,5
0_0118:0060	60	CA	1001,45	1957,22	2,25			2	12	0,5	3	25	8,3			2	0,7

MALno.	Field no.	Area	X (N)	Y	Z	Sampling depth	Lab. note	MS	MS550	LOI(%)	P°	Ptot	Pquota	pH	µS	Shell	Grain size quota <2mm/>2mm
0_0118:0061	61	CA	1003,32	1957,85	2,32			3	10	0,3	2	3	1,7			2	2,0
0_0118:0062	62	CA	1005,29	1958,31	2,27	11 cm		3	8	0,3	3	5	1,6			2	7,5
0_0118:0063	63	CA	1007,29	1958,80	2,28			3	6	0,3	9	6	0,7			2	7,3
0_0118:0064	64	CA	1009,26	1959,18	2,33			3	10	0,3	2	4	2,1			2	4,9
0_0118:0065	65	CA	1011,25	1959,60	2,34			2	8	0,3	2	3	1,7			2	1,2
0_0118:0066	66	CA	1013,14	1959,91	2,34			7	10	0,3	21	8	0,4			2	0,9
0_0118:0067	67	CA	1015,10	1960,25	2,30			7	14	0,5	35	17	0,5			2	0,2
0_0118:0068	68	CA	1017,07	1960,56	2,25	6 cm		3	14	0,4	23	11	0,5			2	0,5
0_0118:0069	69	CA	1023,05	1961,22	2,23			5	14	0,9	14	32	2,3			0	0,3
0_0118:0070	70	CA	1025,12	1961,32	2,41			5	16	0,5	27	10	0,4			1	0,4
0_0118:0071	71	CA	1026,97	1961,62	2,42			7	16	0,9	27	28	1,0			1	0,5
0_0118:0072	72	CA	1029,01	1961,76	2,39			5	14	0,3	7	6	0,9			2	0,4
0_0118:0073	73	CA	1031,01	1961,82	2,42			12	20	0,6	16	21	1,3			2	0,4
0_0118:0074	74	CA	1000,13	1979,94	2,60			2	12	0,3	10	6	0,6			2	0,4
0_0118:0075	75	CA	1002,23	1980,15	2,59			5	20	0,8	24	32	1,3			2	0,5
0_0118:0076	76	CA	1007,08	1980,31	2,53			3	10	0,7	10	12	1,2			2	0,2
0_0118:0077	77	CA	1009,13	1980,33	2,60			3	10	0,4	8	16	2,0			2	0,4
0_0118:0078	78	CA	1010,90	1980,36	2,49			3	10	0,4	5	6	1,2			2	0,5
0_0118:0079	79	CA	1013,18	1980,42	2,59			3	10	0,3	22	14	0,7			2	0,4
0_0118:0080	80	CA	1014,97	1980,47	2,60			7	14	0,5	22	12	0,6			2	0,2
0_0118:0081	81	CA	1017,03	1980,51	2,65		Wood	3	12	0,4	7	11	1,6			2	0,3
0_0118:0082	82	CA	1019,12	1980,56	2,67			3	14	0,5	13	30	2,3			2	0,3
0_0118:0083	83	CA	1021,02	1980,69	2,53			10	16	0,4	21	10	0,5			2	0,3
0_0118:0084	84	CA	1023,09	1980,73	2,46		Org. material	5	14	2,4	21	26	1,2			1	0,6
0_0118:0085	85	CA	1025,18	1980,75	2,47			3	14	2,8	5	13	2,6			2	0,7
0_0118:0086	86	CA	1026,92	1980,76	2,45			3	10	1,2	16	10	0,6			1	0,5
0_0118:0087	87	CA	1029,02	1980,76	2,68			8	18	0,7	12	13	1,1			1	0,2
0_0118:0088	88	CA	1030,97	1980,80	2,67			3	14	0,6	24	18	0,7			1	1,1
0_0118:0089	89	CA	1032,95	1980,86	2,63	5 cm		5	14	0,5	38	30	0,8	7,74	83,1	0	0,4
0_0118:0090	90	CA	1035,07	1980,81	2,58			5	12	0,4	30	17	0,6			1	0,2
0_0118:0091	91	CA	1001,31	1977,68	2,45			7	12	0,5	8	10	1,3			2	0,9
0_0118:0092	92	CA	1003,34	1977,81	2,34			7	12	0,5	19	7	0,4			2	0,5
0_0118:0093	93	CA	1005,35	1978,03	2,42			5	8	0,4	5	6	1,2			2	0,6
0_0118:0094	94	CA	1007,26	1978,01	2,42			3	8	0,4	6	13	2,2			2	0,6
0_0118:0095	95	CA	1009,34	1978,16	2,43			3	12	0,3	14	10	0,7			2	0,7
0_0118:0096	96	CA	1011,30	1978,04	2,46	8 cm		5	10	0,3	6	5	0,8			2	0,4
0_0118:0097	97	CA	1013,28	1978,06	2,50			5	14	0,3	7	12	1,7			2	0,8
0_0118:0098	98	CA	1015,15	1978,10	2,58			7	12	0,3	8	5	0,6			2	0,4
0_0118:0099	99	CA	1017,21	1978,11				7	14	0,5	28	9	0,3			2	0,4
0_0118:0100	100	CA	1019,29	1978,11	2,63			5	14	0,4	34	34	1,0			2	0,5
0_0118:0101	101	CA	1021,33	1978,31	2,47			5	12	0,6	9	12	1,3			2	0,6
0_0118:0102	102	CA	1023,13	1978,46	2,47			12	14	0,4	30	21	0,7			0	0,4
0_0118:0103	103	CA	1025,30	1978,52	2,50	4 cm dj.		5	12	1,4	19	24	1,3			0	1,8
0_0118:0104	104	CA	1027,14	1978,65	2,46			7	16	0,6	27	25	0,9			1	0,1
0_0118:0105	105	CA	1029,08	1978,69	2,59	10 cm dj.		2	8	0,3	13	20	1,5			2	0,4
0_0118:0106	106	CA	1031,12	1978,92	2,61			3	10	0,6	19	16	0,8			2	0,4
0_0118:0107	107	CA	1033,09	1978,82	2,58			5	12	0,6	12	17	1,4			2	0,6
0_0118:0108	108	CA	1035,13	1978,80	2,43			5	10	0,3	19	16	0,8			2	0,3
0_0118:0109	109	CA	1000,90	1969,64	2,23			3	10	0,8	6	11	1,8			2	0,5
0_0118:0110	110	CA	1002,88	1969,80	2,34			18	18	0,5	8	9	1,1			2	0,5
0_0118:0111	111	CA	1004,74	1970,00	2,39			3	8	0,3	3	4	1,4			2	1,4
0_0118:0112	112	CA	1006,91	1970,09	2,39			7	10	0,6	17	23	1,4			2	0,4
0_0118:0113	113	CA	1008,90	1970,33	2,50		Wood	10	12	0,6	31	8	0,3			2	0,3
0_0118:0114	114	CA	1010,81	1970,46	2,46			5	12	0,6	22	24	1,1			2	1,2
0_0118:0115	115	CA	1012,81	1970,55	2,58			8	15	0,6	18	26	1,5			1	0,6
0_0118:0116	116	CA	1014,92	1970,59	2,47			5	10	0,3	14	9	0,6			2	1,8
0_0118:0117	117	CA	1016,84	1970,47	2,44			3	10	0,4	30	23	0,8			1	1,3
0_0118:0118	118	CA	1018,77	1970,66	2,47			5	14	0,4	25	15	0,6			1	0,6
0_0118:0119	119	CA	1025,04	1970,76	2,48			8	16	0,6	34	72	2,1			1	0,5
0_0118:0120	120	CA	1026,83	1970,52	2,55			3	14	0,5	9	11	1,2			2	0,5
0_0118:0121	121	CA	1028,66	1970,48	2,60			3	14	0,4	14	13	0,9			2	0,5
0_0118:0122	122	CA	1030,58	1970,46	2,57			5	14	0,4	23	25	1,1			2	0,4
0_0118:0123	123	CA	1032,56	1970,29	2,51			7	18	0,5	23	23	1,0			2	0,3
0_0118:0124	124	CA	1034,83	1970,21	2,41			7	14	2,8	20	29	1,4			0	0,3
0_0118:0125	125	CA	1000,13	1957,67	2,30	7 cm		3	10	0,4	10	18	1,8			2	0,8
0_0118:0126	126	CA	1002,20	1957,74	2,31			3	14	0,3	3	18	6,0			2	1,0

MALno.	Field no.	Area	X (N)	Y	Z	Sampling depth	Lab. note	MS	MS550	LOI(%)	P°	Ptot	Pquota	pH	µS	Shell	Grain size quota <2mm/>2mm
0_0118:0127	127	CA	1004,09	1957,77	2,25			5	10	0,3	5	3	0,7			2	5,0
0_0118:0128	128	CA	1006,23	1957,91	2,26			5	14	0,4	9	16	1,8			2	1,1
0_0118:0129	129	CA	1008,14	1957,89	2,26			3	12	0,5	7	14	2,0			2	5,0
0_0118:0130	130	CA	1010,28	1957,93	2,30			3	10	0,3	17	4	0,2			2	1,2
0_0118:0131	131	CA	1012,16	1957,99	2,30			0	10	0,3	4	5	1,2			2	1,0
0_0118:0132	132	CA	1014,14	1958,07	2,36			3	14	0,4	20	14	0,7			2	0,7
0_0118:0133	133	CA	1016,26	1958,07	2,26		Wood	3	18	0,9	28	23	0,8			1	0,3
0_0118:0134	134	CA	1018,01	1958,14	2,23			5	16	0,6	25	21	0,9			1	0,8
0_0118:0135	135	CA	1024,31	1957,90	2,28			2	12	0,3	34	30	0,9			1	0,6
0_0118:0136	136	CA	1026,16	1957,86	2,31		Turf/wood?	0	16	0,5	24	6	0,2			1	0,6
0_0118:0137	137	CA	1028,06	1957,93	2,31			2	14	0,9	25	21	0,9			1	1,1
0_0118:0138	138	CA	1029,96	1957,82	2,36		Wood/bark	2	18	0,7	23	12	0,5			2	0,5
0_0118:0139	139	CA	1031,98	1957,79	2,35			3	14	0,4	30	21	0,7			2	0,7
0_0118:0140	201	CA	1001,09	1973,63	2,36		Metal. Lichen & twig?	3	18	1	18	14	0,8			2	0,9
0_0118:0141	202	CA	1002,94	1973,92	2,30		Wingpen. Lichen/moss	2	12	1,1	12	21	1,8			1	0,5
0_0118:0142	203	CA	1004,96	1974,07	2,38			5	20	0,4	8	18	2,2			2	0,5
0_0118:0143	204	CA	1007,00	1974,20	2,50			7	16	0,5	10	9	0,9			2	0,4
0_0118:0144	205	CA	1008,97	1974,41	2,48			2	12	0,3	8	8	0,9			2	0,9
0_0118:0145	206	CA	1010,91	1974,61	2,48		Metal?	2	14	0,4	6	8	1,3			2	0,6
0_0118:0146	207	CA	1013,07	1974,84	2,49		Bone fragm.	3	12	0,3	12	7	0,6			2	0,8
0_0118:0147	208	CA	1014,87	1975,01	2,49		Carb. wood?	3	12	0,3	20	5	0,2			2	1,7
0_0118:0148	209	CA	1016,88	1974,91	2,50			7	18	0,4	17	27	1,6			2	0,6
0_0118:0149	210	CA	1018,90	1974,81	2,51			2	12	0,3	34	23	0,7			1	1,0
0_0118:0150	211	CA	1020,96	1974,73	2,50		Wood/bark	7	16	0,4	28	23	0,8			2	0,5
0_0118:0151	212	CA	1022,84	1974,67	2,45		Much turf	7	17	4	19	25	1,3			0	0,9
0_0118:0152	213	CA	1024,76	1974,63	2,45		Much turf	3	17	3	25	28	1,1			1	1,9
0_0118:0153	214	CA	1026,86	1974,57	2,53			3	14	0,7	19	10	0,5			2	0,7
0_0118:0154	215	CA	1028,89	1974,76	2,57			3	12	0,9	22	19	0,8			1	1,0
0_0118:0155	216	CA	1030,76	1974,65	2,58			7	14	0,7	12	21	1,7			2	0,4
0_0118:0156	217	CA	1032,94	1974,58	2,58			5	12	0,7	28	24	0,9			0	0,5
0_0118:0157	218	CA	1034,90	1974,52	0,00			7	16	0,4	21	25	1,2			0	0,5
0_0118:0158	219	CA	1000,91	1965,67	2,30			3	14	0,3	12	4	0,3			2	1,5
0_0118:0159	220	CA	1002,91	1965,70	2,22			2	16	0,4	2	6	3,1			2	0,5
0_0118:0160	221	CA	1004,94	1965,93	2,33			3	10	0,4	4	8	1,9			2	0,4
0_0118:0161	222	CA	1006,86	1966,06	2,30			7	16	0,3	13	8	0,6			2	0,3
0_0118:0162	223	CA	1008,89	1966,09	2,49			2	12	0,3	3	8	2,8			2	0,8
0_0118:0163	224	CA	1010,88	1966,10	2,57			3	12	0,5	3	12	3,9			2	0,7
0_0118:0164	225	CA	1012,93	1966,14	2,67			3	10	0,4	11	6	0,6	8,13	59,2	2	0,5
0_0118:0165	226	CA	1014,73	1966,12	2,37			5	16	0,7	25	24	1,0			2	0,5
0_0118:0166	227	CA	1016,78	1966,15	2,32			3	12	0,6	21	8	0,4			2	0,6
0_0118:0167	228	CA	1018,78	1966,28	2,34			5	16	1	24	21	0,9			1	0,4
0_0118:0168	229	CA	1024,73	1966,16	2,34			5	10	0,3	21	4	0,2			2	0,4
0_0118:0169	230	CA	1026,74	1966,07	2,44			3	12	2,3	17	28	1,6			1	3,1
0_0118:0170	231	CA	1029,04	1966,13	2,46			5	14	1	26	19	0,7			2	0,6
0_0118:0171	232	CA	1030,59	1965,87	2,45			7	16	0,9	17	30	1,7			1	0,3
0_0118:0172	233	CA	1032,73	1965,96	2,39			8	14	0,9	27	23	0,9			1	0,6
0_0118:0173	234	CA	1034,67	1965,91	2,29			8	14	0,6	32	30	0,9			1	0,3
0_0118:0174	235	CA	1036,65	1965,90	2,50			5	12	0,4	17	19	1,1			1	0,5
0_0118:0175	235	CA	1036,65	1965,90	2,50			5	12	0,5	14	13	0,9			2	0,6
0_0118:0176	236	CA	1039,01	1965,90	2,56			7	12	1,2	19	20	1,1			1	0,6
0_0118:0177	237	CA	1000,88	1961,69	2,33			3	14	0,3	10	5	0,5			2	1,0
0_0118:0178	238	CA	1002,73	1961,81	2,28			3	12	0,5	28	18	0,6			2	0,9
0_0118:0179	239	CA	1004,73	1961,70	2,33			2	10	0,3	3	5	1,6			2	0,7
0_0118:0180	240	CA	1006,79	1961,85	2,36			8	16	0,4	17	9	0,5			2	1,0
0_0118:0181	241	CA	1008,77	1961,80	2,44			7	16	0,4	6	22	3,7			2	1,1
0_0118:0182	242	CA	1010,75	1961,86	2,39			3	12	0,3	3	7	2,3			2	1,4
0_0118:0183	243	CA	1012,70	1961,93	2,37			3	12	0,2	6	6	0,9			2	8,9
0_0118:0184	244	CA	1014,83	1961,88	2,32			3	16	0,3	8	7	0,9			2	0,9

MALno.	Field no.	Area	X (N)	Y	Z	Sampling depth	Lab. note	MS	MS550	LOI(%)	P°	Ptot	Pquota	pH	µS	Shell	Grain size quota <2mm/>2mm
0_0118:0185	245	CA	1016,74	1961,96	2,32			3	14	0,5	21	21	1,0			2	1,3
0_0118:0186	246	CA	1018,68	1961,95	2,22			5	16	0,6	17	18	1,1			1	0,6
0_0118:0187	247	CA	1024,71	1961,60	2,37			5	18	0,4	20	21	1,0			1	0,8
0_0118:0188	248	CA	1026,68	1961,62	2,42			8	20	0,8	30	15	0,5			2	0,6
0_0118:0189	249	CA	1028,68	1961,59	2,40			3	12	0,5	17	17	1,0			1	2,3
0_0118:0190	250	CA	1030,74	1961,65	2,41			3	16	0,6	25	29	1,2			2	0,6
0_0118:0191	251	CA	1032,56	1961,74	2,34			3	20	1,5	27	25	0,9			1	0,7
0_0118:0192	301	CA	1017,06	1992,12	2,77		Fibre? Moss	0	12	0,4	17	11	0,6			2	7,4
0_0118:0193	302	CA	1019,73	1991,33	2,86			3	12	0,3	21	10	0,5			2	0,8
0_0118:0194	303	CA	1021,77	1990,20	2,74			3	18	0,4	11	12	1,1	8,21	53,7	2	0,4
0_0118:0195	304	CA	1024,06	1989,32	2,78		Rusty flakes	40	99	0,6	20	16	0,8			2	1,5
0_0118:0196	305	CA	1025,31	1991,47	2,65			2	15	3,1	14	22	1,6			0	0,3
0_0118:0197	306	CA	1023,56	1992,79	2,75			3	12	0,6	23	15	0,7			2	0,4
0_0118:0198	307	CA	1021,02	1993,99	2,84			5	12	0,3	14	6	0,4			2	0,4
0_0118:0199	308	CA	1019,47	1995,43	2,84			0	8	0,2	12	7	0,6			2	3,7
0_0118:0200	309	CA	1020,73	1998,48	3,07			3	8	0,3	25	16	0,6			2	0,4
0_0118:0201	310	CA	1022,81	1997,13	2,96		Fibres	5	10	0,3	17	9	0,5			2	0,5
0_0118:0202	311	CA	1024,98	1995,69	2,73			7	12	0,5	18	24	1,3			2	0,3
0_0118:0203	312	CA	1026,99	1994,16	2,62			3	10	1	22	26	1,2			0	0,8
0_0118:0204	313	CA	1028,62	1997,24	2,76			3	14	1,2	25	39	1,5			0	0,3
0_0118:0205	314	CA	1026,78	1998,58	2,86			5	16	1,8	19	22	1,1			0	1,5
0_0118:0206	315	CA	1025,14	1999,85	2,98			5	10	0,4	18	22	1,2			1	0,5
0_0118:0207	316	CA	1022,49	2001,56	3,08			3	14	0,9	21	19	0,9	7,55	81,3	1	0,3
0_0118:0208	401:1	CS	987,14	1957,98	2,34			2	6	0,2	1	3	2,6			2	91,0
0_0118:0209	401:2	CS	987,14	1957,98	2,34	10 cm		0	2	0,2	1	3	2,6			2	7,6
0_0118:0210	402	CS	976,80	1959,53	2,28			3	10	0,6	27	22	0,8			2	0,9
0_0118:0211	403	CS	965,28	1961,15	2,22			5	8	0,4	10	7	0,8			2	1,8
0_0118:0212	404	CS	955,37	1962,24	2,14			3	8	0,6	6	5	0,7			2	0,8
0_0118:0213	405	CS	944,83	1964,67	1,89			3	4	0,4	2	7	3,2			2	1,1
0_0118:0214	406	CS	932,20	1965,60	1,84			2	2	0,3	3	4	1,1	8,78	64,8	2	0,7
0_0118:0215	407	CS	936,94	1977,36	2,15			2	4	0,4	3	6	2,2			2	3,5
0_0118:0216	408	CS	929,29	1955,51	1,81			2	6	0,4	2	4	1,9			2	1,1
0_0118:0217	409	CS	925,18	1945,56	1,76			7	6	0,3	6	3	0,6			2	0,6
0_0118:0218	410	CS	939,25	1951,04	1,86			3	6	0,5	4	3	0,6			2	0,9
0_0118:0219	411	CS	947,73	1946,33	1,96			2	8	0,3	5	5	1,1			2	17,9
0_0118:0220	412	CS	957,86	1944,20	1,89			3	10	1	28	30	1,1			1	0,7
0_0118:0221	413	CS	967,57	1941,85	2,01			8	16	1,4	30	25	0,8			2	0,6
0_0118:0222	414	CS	976,34	1937,46	2,00			3	6	0,3	8	4	0,5			2	15,4
0_0118:0223	415	CS	986,31	1936,01	2,09			2	4	0,2	3	4	1,4			2	6,3
0_0118:0224	416	CS	996,11	1935,71	2,13			5	6	0,4	6	9	1,7	8,64	60	2	0,9
0_0118:0225	417	CS	995,29	1925,01	2,26			5	10	0,5	19	5	0,3			2	1,1
0_0118:0226	418	CS	993,77	1913,06	2,29			3	6	0,5	3	8	2,9	8,23	126,2	2	2,3
0_0118:0227	419	CS	1014,07	1945,57	2,44			3	8	0,3	6	4	0,6			2	1,9
0_0118:0228	420	CS	1025,86	1947,50	2,18			3	10	0,3	26	20	0,7			2	0,3
0_0118:0229	421	CS	1023,70	1938,22	2,11			3	8	0,4	1	15	10,8			2	1,0
0_0118:0230	422	CS	1017,38	1930,60	2,41			2	8	0,3	10	22	2,3			2	0,8
0_0118:0231	423	CS	1013,26	1909,52	2,28			8	14	0,4	14	16	1,1			2	0,5
0_0118:0232	424	CS	1049,57	1954,11	2,53			7	14	0,4	31	32	1,0	7,57	73,1	2	0,5
0_0118:0233	425	CS	1061,60	1955,74	2,73			5	25	2	38	36	0,9			0	0,4
0_0118:0234	426	CS	1072,35	1961,57	2,80			5	12	0,8	25	22	0,9			1	0,3
0_0118:0235	427	CS	1077,33	1977,77	3,26			3	10	0,3	8	7	1,0			2	1,3
0_0118:0236	428	CS	1077,31	1998,80	3,31			2	8	0,6	2	6	2,9			2	2,9
0_0118:0237	429	CS	1082,40	2010,86	3,58			3	8	0,6	3	7	2,7	7,79	80,5	2	0,8
0_0118:0238	430	CS	1059,92	1981,17	3,03			5	12	0,5	19	6	0,3			2	0,4
0_0118:0239	431	CA	1010,32	1992,31	3,51		Wood	2	8	0,6	14	20	1,4			1	7,0
0_0118:0240	432	CA	1009,91	1992,33	3,53		Fibres	2	10	0,7	32	29	0,9			1	5,2

1. *Erik Norberg*. Rapport över arkeologisk undersökning av fornlämning Raä 249, Karl-Gustav sn, Norrbotten. Anläggning 6 hyddbotten och anläggning 7 boplatsgrop. Umeå 1995.
2. *Erik Norberg*. Rapport över arkeologisk undersökning av fornlämning Raä 249, Karl-Gustav sn, Norrbotten. Anläggning 5, hyddbotten. Umeå 1996
3. *Per-Erik Egebäck*. Rapport över arkeologisk undersökning, Pörnullbacken, Vörå sn, Österbotten. Osteologisk rapport: Barbro Hårding. Arkeobotanisk rapport: Karin Viklund. Umeå 1996.
4. *Anna-Karin Lindqvist med bidrag av Per H. Ramqvist och Barbro Hårding*. Gallsätter. Arkeologisk undersökning av fornl. komplex Raä 7, Skog sn, Ångermanland 1994-1995. Umeå, 1996. **(OBS Utvidgad färgedition finns också att beställa på CD, för Mac eller PC)**
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22. *Erik Norberg och Leif Jonsson (osteologisk rapport)*. Rapport över arkeologisk undersökning av fornlämning Raä. 249 Karl-Gustavs sn. 1997. Umeå 2001.

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