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Human Impact at Advent City (RiS ID 10516)

August 5 – August 16, 2016

Post-excavation assessment report

Source: Wilse, A.B. 1906. NF.W 05522. Galleri NOR [online].

Kruse, F. *et al.* 2016. Human impact at Advent City (RiS ID 10516). Post-excavation assessment report. [Unpublished report.] Groningen: University of Groningen, Arctic Centre.

Non-technical summary

From August 5 till 16, 2016, a team of archaeologists and botanists carried out interdisciplinary fieldwork at Advent City in Adventfjord on Spitsbergen (Svalbard, Arctic Norway). Coal had first been claimed at this location in summer 1901, and from summer 1904, the settlement of Advent City was the focal point of the mining activities of the Spitzbergen Coal and Trading Company. The company town was abandoned in autumn 1908, and by 1917, all buildings and most plant had been removed, much of it to Hiorthhamn, and the site had fallen out of use. Advent City is therefore a well-delineated archaeological site and a powerful reminder of a bygone industrial era.

As part of Kruse's ongoing post-doc project on the ecological consequences of 400 years of natural-resource exploitation in Svalbard, **the aims for this fieldwork were to investigate the human-induced environmental impact at Advent City at different spatial and temporal scales**. For this purpose, the team made use of topographic survey by dGPS, 3D photogrammetry, archaeological evaluation, and vegetation survey. This report deals primarily with the results and potential of the excavated evaluations trenches.

A stable and a domestic dump were evaluated. The stable had been built in at least two stages. The western part was constructed in winter 1906/7; it was associated with midden M1 that comprised horse dung but surprisingly few artefacts. The eastern part was extended in spring/summer 1907; it was associated with midden M2 that comprised a capping layer of butchered cattle bone. Whether it had been a piggery could not be established in the field. Manufactured finds were again few. Dump Z1 was linked to a workers' barrack used from summer 1905 probably until site abandonment. It contained mainly ash and few finds, but a significant bone assemblage is most likely of ptarmigan. Despite extensive additional field observations of varied origin and character: the site gives the impression of systematic and thorough salvaging.

The artefacts do not hold much environmental information: they will be conserved and returned to the Svalbard Museum as soon as possible. The environmental material, however, encompasses much bone from different animal species as well as imported plants in the form of hay and straw. The largest seeds have already been hand-collected. Information obtained in the field and during the impending zooarchaeological, palaeo-botanical, and palynological analyses (coupled with the results of the vegetation survey) are thought to answer the fieldwork's research questions almost in full. In addition, there may

be the finances to carry out C14 dating of selected animal bones from the closely dated deposits with the aim of testing the marine reservoir effect at Advent City.

The project received much public attention when two polar bears showed up and disrupted the fieldwork to a point of the team needing to evacuate the site several days earlier than planned. By that time, the team had been able to carry out most of the intended tasks. The bears were very well behaved indeed, so that the site and the camp were never in danger of destruction.

Two archaeologically-minded polar bears. Photo courtesy of Elisabeth Kadden, August 2016.

Keywords

Svalbard, Spitsbergen, Advent City, archaeology, botany, fieldwork, natural resources, mining, exploitation, human impact, Arctic ecosystem

Content

1. Introductory statements

1.1 Acknowledgements

This fieldwork was carried out as a part of Dr Frigga Kruse's post-doctoral research at the Arctic Centre of the University of Groningen. It was financed by the Netherlands Organisation for Scientific Research (NWO). The necessary permissions were granted by Norway's Directorate for Cultural Heritage (*Riksantikvaren*) and the Governor of Svalbard (*Sysselmannen*). Our outreach and publicity efforts were supported by the Svalbard Museum, Svalbard Science Destination, and Svalbardposten. Dr Maarten Loonen of the Arctic Centre in Groningen and Dr Hans Kruijer of Naturalis in Leiden gave invaluable scientific guidance.

The fieldwork team comprised the archaeologists Dr Frigga Kruse, Dr Gary Nobles, Martha de Jong, and Rosanne van Bodegom as well as the botanists Elisabeth (Liesbeth) Leusink, Lydia Messingfeld (part), and Bardo Cornelder (part). We are indebted to the local police and the many Longyearbyen residents who made sure that we were safe by the time two polar bears came to the site and to our camp. A big thank-you also to Captain Joachim Schiel, Michelle van Dijk, and the crew of the SV *Antigua* for providing the motorised means to "get the hell out of there". These and other exciting moments on site can be re-lived on the public Facebook page "Polar bear says".

1.2 Circumstances of the project

This fieldwork has been registered as "Human Impact at Advent City" in the Research-in-Svalbard database (RiS ID 10516). It is part of the post-doc project "Ecological Consequences of Four Hundred Years of Natural-Resource Exploitation in Svalbard" (RiS ID 6917). Directly linked to it is the botanical survey "Vegetation Succession After Human Impact at Advent City" (RiS ID 10597).

Both the archaeological and the botanical fieldwork took place on the site of the former mining settlement of Advent City (position former manager's house 78.2701° N 15.6297° E) on the east side of Adventfjorden. Ca. 5 km of water separate the site from the capital of Longyearbyen to the south (**Fig. 1.1**).

The team had planned to be on site from August 5 till August 18, 2016, with a weekend break in Longyearbyen. Due to the interruption by two polar bears, fieldwork was

only possible between August 5 and August 12, 2016. On August 16, 2016, the team briefly returned to the site to backfill the trenches and evacuate the camp.

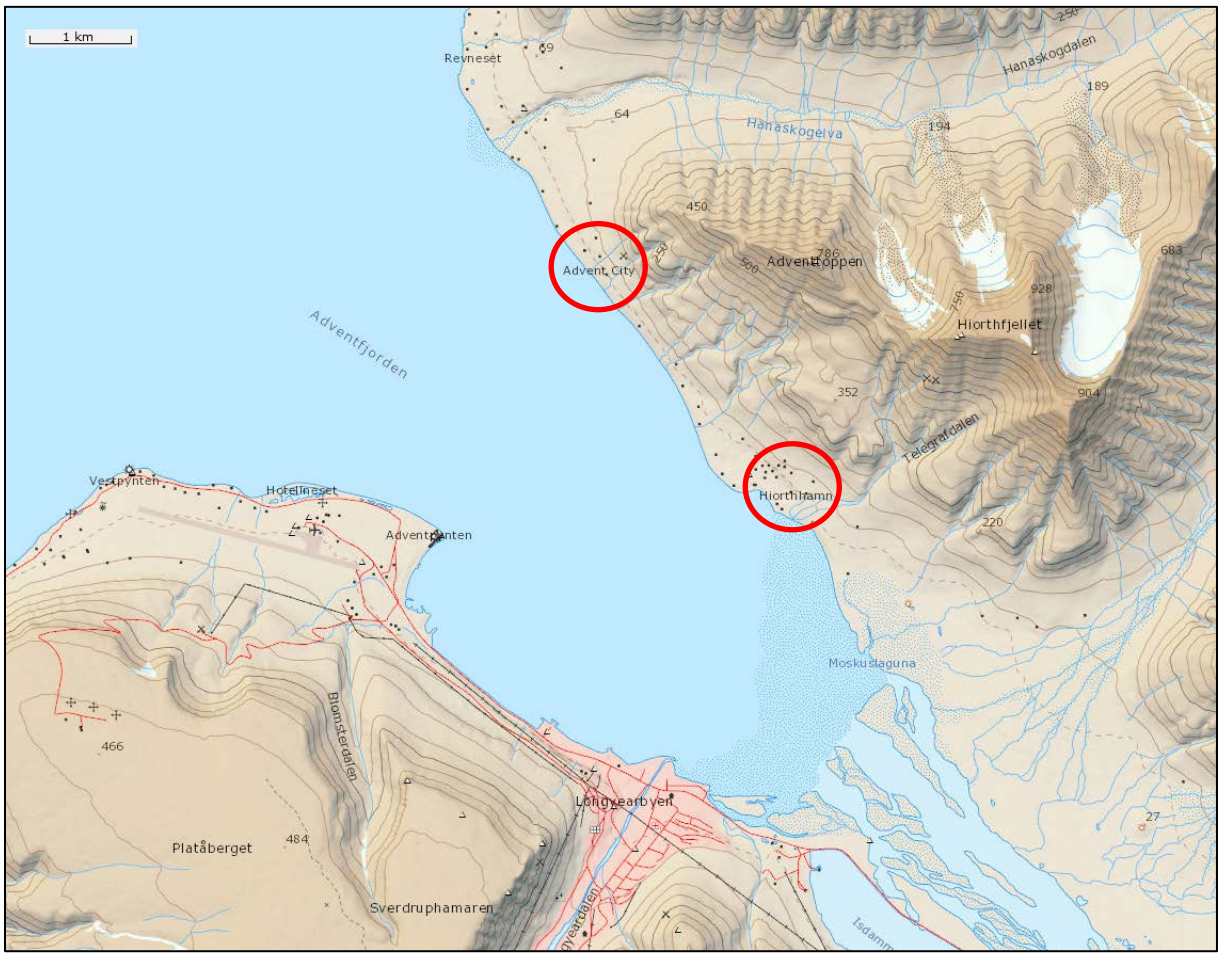

Fig. 1.1 Location map of Advent City, which lies approximately 5 km north of Longyearbyen. The distance between Advent City and Hiorthhamn to the southeast is around 2.5 km. (Source: TopoSvalbard.npolar.no)

1.3 Historical and archaeological background

According to *The place names of Svalbard* (2003), ***Advent City*** (78° 10' N 15° 30' E) is a "deserted mining camp on the eastern side of Adventfjorden, north of Nordenskiöld Land. Was built by the Spitzbergen Coal and Trading Company Limited of Sheffield 1904 and 1905. In the first year only one mess hut was built, but the next summer several houses, including a bakery, were erected (two streets). In 1916-17 the remaining houses were moved to Hiorthhamn, now Moskushamn, some 2.5 km to the southeast at the same fiord [**Fig. 1.1**]. Only the foundations are now left. Name given by the company." Recent historical-archaeological research has indicated that this description is only partially correct.

The geological map (**Fig. 1.2**) shows underlying bedrock of the Janusfjellet Subgroup (bitum, shale, siltstone, sandstone) of the Middle Jurassic to Early Cretaceous in blue and

bedrock of the Helvetiafjellet and Carolinefjellet Formations (clastic sedimentary rocks, mainly sandstone) of the Early Cretaceous in green. From this low-resolution geological map, it is not immediately obvious that the sedimentary layers also contain coal.

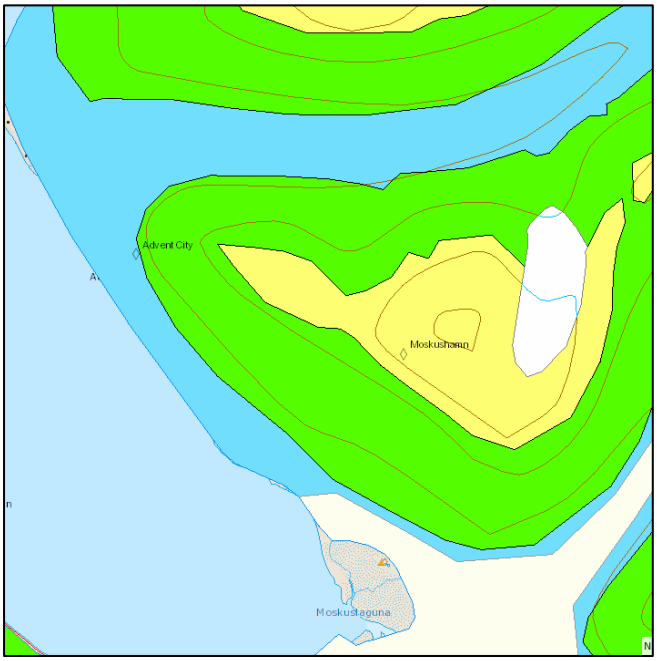

Fig. 1.2 Geological map of Advent City and Hiorthhamn (Moskushamn): the Janusfjellet Subgroup of the Middle Jurassic to Early Cretaceous in blue, the Helvetiafjellet and Carolinefjellet Formations of the Early Cretaceous in green, and the lower part of the Van Mijenfjorden Group comprising coal seams from the Palaeocene in yellow. (Source: SvalbardKartet.npolar.no)

The Spitzbergen Coal and Trading Company Limited was not the first group to explore coal at this location, but it was the most active and created the majority of the archaeological record on site. In her thesis, KRUSE (2013) outlines the company's formation and development as follows,

> "The Norwegian predecessor was the A/S Bergen-Spitsbergen Kulgrubekompani or simply Bergen Co. In 1901, seven men arrived on the northern shore of Advent Bay and located coal on the hillside approximately 100 metres above sea level. Using metal wire, the party fenced off a claim and erected wooden boards along its boundary. The main board read that the property had been occupied on July 22 and that it was delineated by a boundary between Advent Bay and Sassen Bay. In addition, the men built a shed to store tools and explosives. They then left for Kings Bay, where they found coal on the southern shore and took possession of it in a similar manner. The total output that year was five tons of coal, which was taken to Norway for tests.
>
> In 1903, an expedition of 15 under the leadership of the Norwegian engineer Stener August Fangen arrived at Advent Bay at the beginning of June. The group anchored close to the place that would become Advent City. The water was too shallow for the ship to approach the shore, so equipment and supplies were discharged in rowing boats, which was an

unassuming task in calm weather. Although a kitchen and a mess tent were put up, the men mainly lived and slept on board.

During the summer, the men drove an adit of 80 metres into the coal seam. They levelled the gradient at the mine and built simple retaining walls. The pithead arrangements included a railway track into the mine, some winding gear, and a small smithy. The simple ropeway transported the coal downhill to the coast. By the end of the season, the Bergen Co. had extracted approximately 40 tons of coal. Some filled the stores of a Hurtigruten ship. Some was used on the expedition's own journey from Tromsø to Bergen. An amount of coal also fuelled a locomotive on the Bergen-Voss railway, and the remainder was sent to Bergen's gas plant for further tests.

Armed with favourable reports, Fangen travelled to England in autumn 1903. He had formerly been employed by Emerson Muschamp Bainbridge and now met the coalowner in London to promote the Arctic coal mine. Besides making a financial contribution, Bainbridge put the Norwegian in touch with colleagues and friends, who would be instrumental in the formation of the new company. Of these, Jacob Kruuse Müller Hessler was a ship owner and timber merchant as well as the Norwegian consul in West Hartlepool in North East England. William Black had been one-time secretary and manager at Nunnery Colliery Co. Ultimately, Fangen was able to raise about £4,000 in England. The money was most likely intended for a new expedition in 1904.

Following the meeting with Fangen, Bainbridge felt that the Arctic coal mine was worth pursuing and initiated a mining company. The application to the Board of Trade was signed by Bainbridge, Black, and the colliery agent William Austin Marshall Toyne on May 11, 1904. Bainbridge resided in London, but Black, who would be the managing director, was a Sheffield man. The Spitzbergen Coal & Trading Co. was therefore registered in Sheffield. Besides Bainbridge and Black, the board of directors also comprised the solicitor William Edwin Clegg. The colliery clerk Edwin Vickers Weston carried out his secretarial duties at Kings Chambers on Angel Street in the town centre. The Treasury approved a nominal capital of £2,500, which was divided into 2,494 ordinary shares of £1 each and 120 founders' shares of 1s each.

While the new expedition sailed for Spitsbergen, Black signed an agreement with the Spitzbergen Coal & Trading Co. on June 17, 1904. He was acting on behalf of those who had previously invested in the Bergen Co. The shareholders had transferred their rights to Black, who in turn sold all property, assets, and interests of the adventure to the firm. A condition of the agreement was that the Spitzbergen Coal & Trading Co. would issue fully paid up ordinary shares to the former subscribers, the amount being representative of their previous commitment. Accordingly, 1,969 ordinary shares were issued, of which Norwegian investors received 62 per cent, while the residual 38 per cent went to British subscribers. Although the agreement did not specify, which possessions had been signed over and although ownership was seemingly retained by the Norwegians, the Spitzbergen Coal & Trading Co. was ready to commence business.

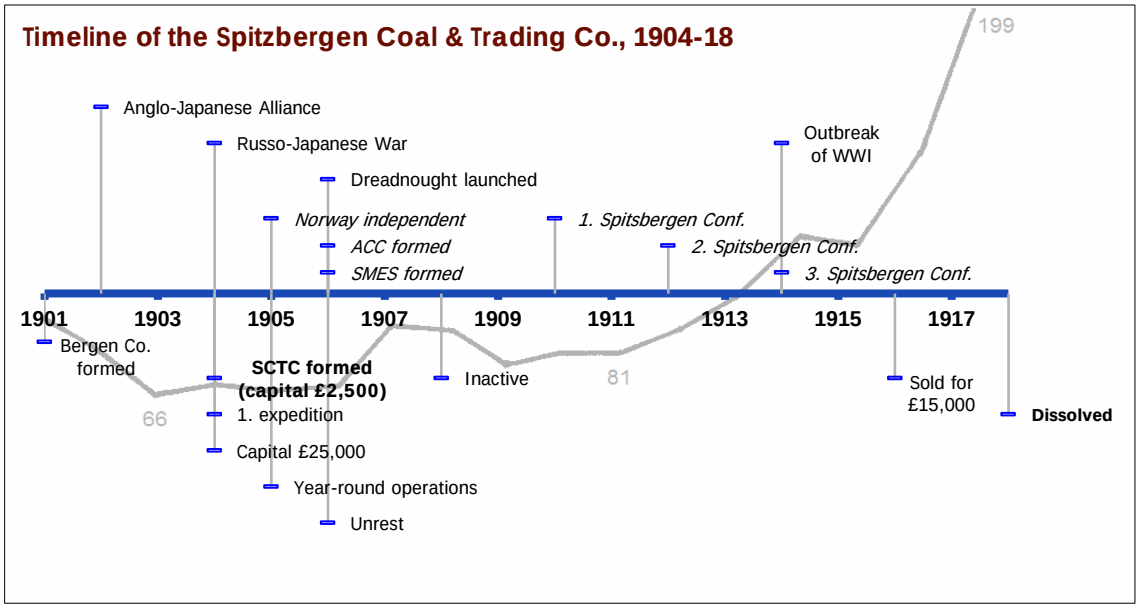

Fig. 1.3 Timeline of the Spitzbergen Coal & Trading Co., 1904-18. Events below the bar are company-specific. Above the bar, events in italics are relevant to Spitsbergen, while others are thought to have defined the global context. The grey line indicates the indexed British coal price movements, whereby the bar denotes 1913 = 100 and the bottom edge approaches 0. Actual percentages have intermittently been added for clarify. (Source: KRUSE 2013.)

The chronological overview in **Fig. 1.3** summarises the subsequent events. The global context was marked by political upheaval. The Anglo-Japanese Alliance, the Russo-Japanese War, and the launching of the first *Dreadnought* battleship signify Britain's emergence from political isolation, a shift in the European balance of power, and the intensification of the arms race with Germany, respectively. All are thought to have contributed to the outbreak of the First World War. Meanwhile, the Swedish-Norwegian union had ended, which fuelled the aspirations of both countries to be the foremost Arctic nation. Shortly afterwards, the Arctic Coal Co. and the Spitzbergen Mining & Exploration Syndicate were founded, which increased the presence of American and British actors in the no man's land. Three Spitsbergen conferences took place to settle the legal status of the islands, but the third had to be postponed indefinitely at the outbreak of war. Economically, the British coal market had barely stabilised after the peak in 1900, with a temporary high in 1907 and 1908, before the rise into abnormally high prices during the war began. A strong British market with correspondingly steep export rates (export being restricted during the war) meant that importers like northern Norway looked for cheaper alternatives. In those periods, Spitsbergen coal was potentially good business. Against this background, the Spitzbergen Coal & Trading Co. sent an expedition in 1904 and increased its capital to £25,000 later in the same year. Year-round operations commenced with the expedition in 1905, followed by unrest that culminated in a strike in winter 1906/7. From autumn 1908, the company was inactive until it sold its properties to a Norwegian entrepreneur during the war. After 14 years in existence, it was eventually dissolved in 1918.

KRUSE (2013) further published a site map of Advent City (**Fig. 1.4**) based on the material remains recorded by the LASHIPA 1 expedition in 2004.

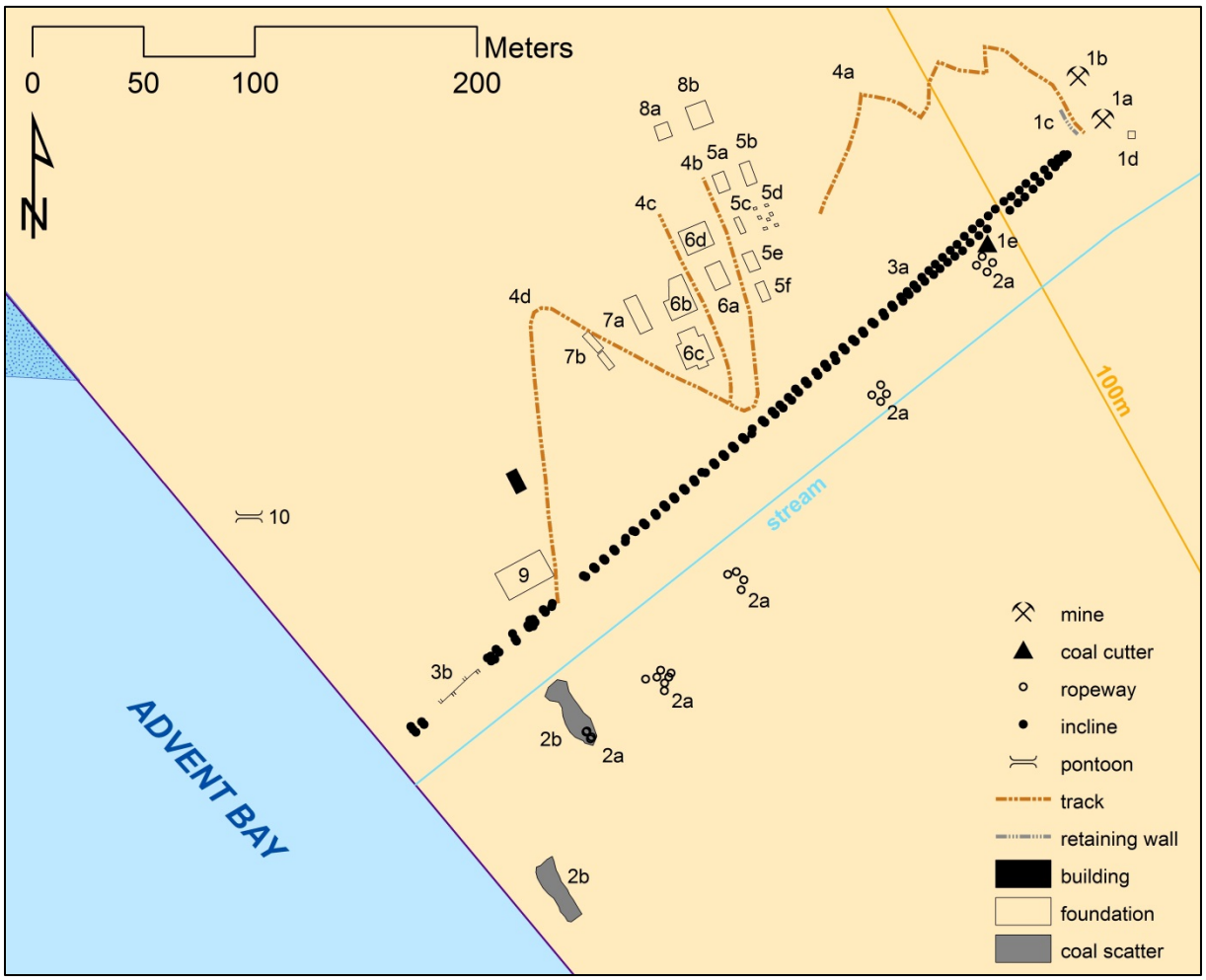

Fig. 1.4 Site map of Advent City. (Data: LASHIPA 1, 2004; Map: F. Kruse, 2013.)

This fieldwork report mostly adheres to KRUSE'S (2013) system of numbering features, but to aid comparison with Norway's official record, the corresponding Askeladden ID have also been included **Table 1.1** below. The most important omissions in either record have been highlighted. After additional fieldwork in 2014 and 2016 (this report), Kruse realises that both records are far from holistic. The site comprises many more significant details that warrant official recognition and better protection.

LASHIPA 1 , 2004 (numbering according to Kruse's (2013) map)		Foosnæs, 2012 (Askeladden ID)	
1a	Mine adit	93035-1	Gruve
1b	Ventilation adit		
1c	Retaining wall	93035-2	Tørrmur

LASHIPA 1 , 2004 (numbering according to Kruse's (2013) map)		Foosnæs, 2012 (Askeladden ID)	
1d	Smithy	93035-3	Bygning
1e	Disc coal cutter		
2a	Aerial ropeway tower	93035-5	Fundament
2b	Coal scatter		
3a	Self-acting incline (posts)	93035-7	Trallebane
3b	Self-acting incline (embankment)	93035-8	Mur
4a	Narrow track, footpath		
4b	'Street'	93035-10	Veitrase
4c	'Street'	93035-10	Veitrase
4d	Wide track, vehicles		
5a	Barrack foundation, earthworks	93035-24	Tuft
5b	Barrack foundation, earthworks	93035-25	Tuft
5c	Barrack foundation, earthworks		
5d	Barrack foundation, sandstone pillars	93035-28	Tuft
5e	Barrack foundation, earthworks	93035-21	Tuft
5f	Barrack foundation, earthworks	93035-20	Tuft
6a	House foundation, earthworks	93035-19	Tuft
6b	House foundation, concrete strip	93035-16	Tuft
6c	House foundation, concrete strip	93035-13	Tuft
6d	House foundation, brick strip	93035-23	Tuft
7a	Building foundation, concrete strip	93035-15	Tuft
7b	Building foundation, timber piles	93035-17	Tuft
8a	Building foundation, concrete strip	93035-26	Tuft
8b	Building foundation, concrete strip	93035-27	Tuft
9	Engine house	93035-9	Maskinhus
10	Coal lighter? Water barge? Pontoon?	93034	Skipsfunn
	next to smithy 1d	93035-4	Tørrmur
	part of incline 3b	93035-6	Fundament
	next to incline 3a	93035-11	Fundament
	next to barrack 5c	93035-22	Trekonstruksjon
		93035-29	Grop (on beach)
		93035-30	Tuft (on beach)
	next to incline 3a	93035-31	Trekonstruksjon
	next to building 7a	93035-32	Trekonstruksjon
	next to houses 8a and 8b	93035-33	Tuft
		158446	Revefelle
		158447	Revefelle
		158448	Revefelle

Table 1.1 Comparison of features recorded by LASHIPA 1 in 2004 (left) and registered by Foosnæs in 2012 (right). Gaps in the table mark gaps in the record.

In addition to discerning the nature of individual features at Advent City, KRUSE (2016a) has recently tracked the year-by-year development of the settlement as well as later site formation processes. **Fig. 1.5** summarises the findings of the unpublished report. **Crucial to this fieldwork, the building identified as the stables and pig house (7b, 93035-17) appears to have been constructed in two phases in as late as winter 1906/7 and summer 1907**. [Surface construction often happened during the dark winter months, but evidence for this

survives in the form of photographs usually taken with the re-appearing light in spring or with the arrival of ships and visitors in summer.]

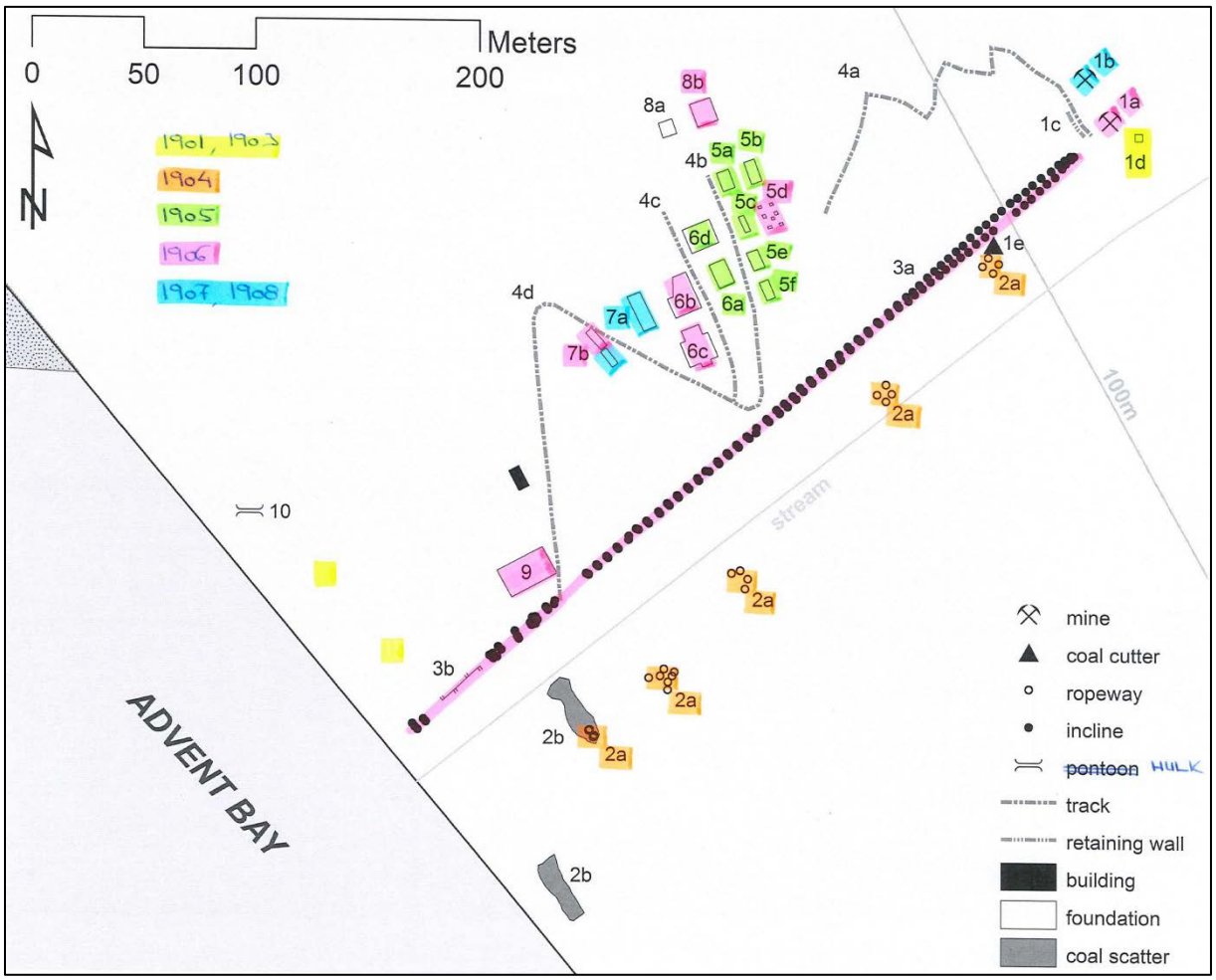

Fig. 1.5 A crude map indicating the chronological development of the mining settlement of Advent City between 1901 and 1908. (Source: KRUSE 2016a.)

Furthermore, to assist the writing of this report, KRUSE (2016b) has compiled written and photographic evidence for activities that may have had local environmental impacts. In brief and roughly temporal order, these appear to have been:

- sending **people** up north in the first place; some summer workforces approached 100
  - by definition, people cause anthropogenic impacts; it is assumed that the greater the number of people on site, the greater the impacts
- extensive **ground-levelling** at pithead, for house foundations, for tracks, and elsewhere
  - physical changes to vegetation, noise pollution (e.g. use of explosives)

- **mining** coal
    - physical changes above and below ground, noise pollution (e.g. use of explosives)
- **stockpiling** coal
    - physical and chemical changes to vegetation
- shooting **seals**
    - reducing local seal population, noise pollution (e.g. firing rifles)
- **quarrying** beach sand
    - physical changes to geo-resources
- hunting **3 reindeer** (where possible, numbers of individuals are included in this list)
    - reducing local reindeer population, noise pollution (e.g. firing rifles)
- importing **paraffin**, **oils**, **carbide** and other chemicals
    - potential chemical changes through spillage and waste products
- importing **4 horses, 2 pigs, 4 dogs, 1 goat**
    - introduction of non-native species, introduction of parasites
- hunting **1 reindeer, 24 reindeer, 123 reindeer, 7 blue foxes, 8 white foxes**
    - reduction local populations
- constructing **2 hunting huts**
    - implying the reduction of populations over a wider area
- **damming** meltwater streams
    - may have caused stream diversion and flooding in the medium- to long-term
- importing **straw and/or hay**
    - introduction of non-native species, introduction of pests
- importing **stockfish**
    - introduction of parasites
- local **fishing**
    - reducing local fish population
- dumping **waste**
    - physical, chemical, and biological changes

1.4 Outline nature of work

The background of this project is one of a growing body of historical-archaeological desk-based research and field survey: HOEL 1966, JOHANNESSEN 1997, LASHIPA 2004, FOOSNÆS 2012, KRUSE 2013, KRUSE 2014, KRUSE 2016a, KRUSE 2016b. Against this background, further study of Advent City benefits from either seeing the bigger picture, that is to take an archaeological landscape approach to the site but also to understand the settlement's development in comparison to the contemporaneous Longyear City (now Longyearbyen, 1906 – present). Or to home in on very specific details such as the origin and changing functions of particular buildings or the consequences of the human activity for the local environment.

This fieldwork was a pilot study to try and tie Advent City into its surroundings on a small to medium scale and to try and discern the human impact of the company town at the time of the mining operations (1901 – 1908) as well as after a century of site abandonment, in which affected local animal populations and vegetation may have recovered. After the site boundaries were carefully delineated according to dominant natural features (see section 1.5 below), the nature of the work carried out was:

- **a topographic survey** of the site using a differential Global Positioning System (hereafter dGPS);
- **3D photogrammetry** of archaeological structures at Advent City as well as Hiorthhamn. The photogrammetry is a separate project, but an indication of its potential will be given in section 4 below.
- **an archaeological evaluation** comprising three trenches, one each across two previously identified middens (KRUSE 2014) and a feature formerly thought of as a latrine (KRUSE 2014) but re-interpreted as a domestic ash dump (KRUSE, this report);
- **a botanical survey** consisting of eleven grids with a focus on potential non-native species and the vegetation succession over the last century. This survey is subject to separate reporting and will not be treated in the sections below.

1.5 Site description

Since the LASHIPA expedition in 2004, topographic mapping in Svalbard has come on leaps and bounds, and the Norwegian Polar Institute has made it possible to consult fairly high-resolution topographic maps and aerial photographs online. In the topographic map in **Fig. 1.6**, the black rectangle roughly outlines the area that would be investigated during the

fieldwork, i.e. the site. In view of previous site work at Advent City always lacking a clear definition and leaving questions as to what was actually surveyed and what was not (!), the team found it important to delineate the site very early on in the planning stages as under the time constraints, we would not be able to concern ourselves with possible archaeological remains outside our chosen site boundary.

Fig. 1.6 shows the terrestrial topography along a small stretch of the north-east coast of Adventfjord; there are no submarine details. Starting with an even coastline, the topographic contours are given in 5-m intervals, but they are unfortunately not labelled. The contours increase fairly regularly until there is a break in slope at approximately 70 m AOD (above ordnance datum). Then the slope becomes rapidly steeper. The site is bound by the coastline, two meltwater streams on either side, and a seemingly arbitrary line at height. On this map, the only features shown within the site are an upstanding modern house and an associated shed (in orange). Had the inclusion of archaeological information been an option, it would be clear that the former mine entrance lies at approximately 110 m AOD and marks the extent of the site here. Beyond the adit, the steep slope is practically inaccessible without aid.

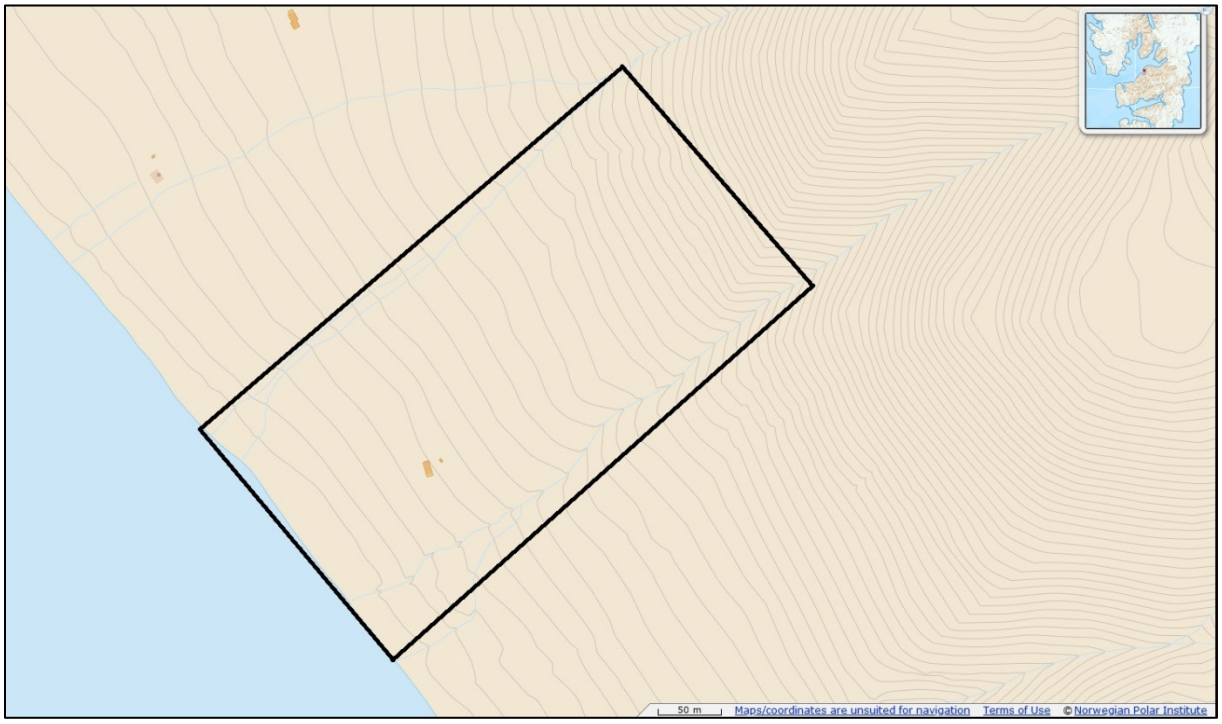

Fig. 1.6 A topographic map of the northeast coast of Adventfjord showing the approximate extent of the site under investigation. (Source: Norwegian Polar Institute, www.toposvalbard.npolar.no)

The strength of **Fig. 1.6** lies in a clear indication of height above sea-level; its shortcomings are addressed in **Fig. 1.7**. At this scale, the aerial photograph gives some detail of submerged features, of which there are some but not many, and these seem to be associated with the meltwater streams and are unlikely to have much archaeological relevance. Prior to the fieldwork taking place, an attempt was made to organise an underwater survey with the local diving club, but this did not take place. Meltwater run-off from the mountains to the north-east, in fact, seems to dictate the geomorphological processes in the map area and on the site. The western meltwater stream fans out over a larger area than the eastern one. The ground and vegetation patterns also suggest soil creep and probably debris flow. In addition to these natural features, the aerial photograph shows the archaeological remains (mine entrance east corner). At this scale, they seem largely unaffected by the most destructive slope processes, the exception being house foundations 8a and 8b perhaps. The fieldwork paid close attention to these slope processes and resultant ground patterns in relation to both archaeological site formation processes and vegetation succession.

Fig. 1.7 Aerial photograph of the northeast coast of Adventfjord showing the archaeological remains at Advent City and indicating the meltwater-related slope and site formation processes. (Source: Norwegian Polar Institute, www.toposvalbard.npolar.no)

2. Aims and objectives

The project design expressed a couple of leading questions and associated sub-questions, the aims of the fieldwork being to answer these:

- **What was the immediate to short-term human-induced (anthropogenic) environmental impact at Advent City?**
- **What is the medium- to long-term human-induced environmental impact at the company town after a century of site abandonment?**
    - What animals and plants were intentionally brought to the site?
    - What animals and plants were unintentionally imported to the site?
    - What animals were obtained locally, e.g. hunted or bought?
    - Did humans and domestic animals suffer from pests (e.g. rats, mice), parasites, or diseases?
    - What was the anthropogenic impact on the local vegetation?
    - What does the archaeological evidence tell us about past human behaviour and provisioning (imported provisions vs local subsistence)?
    - How does the archaeological evidence compare with the historical sources?

The research questions were to be addressed by the following fieldwork objectives:

- mapping the topography and producing a detailed 3D terrain model,
- mapping the vegetation and any surface animal bone (latter not done),
- partially excavating two middens at the former stables,
- partially excavating two ‘latrines’ (turned out to be ash dumps; this report),
- and by carrying out a visual underwater survey in the foreshore zone (not done).

Furthermore, the fieldwork would contribute to:

- facilitating the move away from nationalistic perspectives of economic history towards comprehensive historical ecology,
    - by engaging multidisciplinary peers and other stakeholders in the co-production and utilisation of knowledge, and

- facilitating the revival of Svalbard historical archaeology,
    - by engaging in public outreach and science communication.

3. Methodology

The fieldwork made use of the following organisation's standards and guidelines:

- Chartered Institute for Archaeologists (CIfA, www.archaeologists.net)
    - Standard and guidance for archaeological archives, archaeological materials, historic environment desk-based assessment, archaeological excavation, archaeological field evaluation
    - Risk assessment: larger works
- Historic England (www.historicengland.org.uk)
    - Archaeological science advice and guidance, incl. material science, archaeological conservation, environmental archaeology, scientific dating
- Museum of London Archaeology (MOLA)
    - Archaeological Site Manual

3.1 Topographic survey

The topographic survey was undertaken by Gary Nobles, using a differential GPS (dGPS). The survey took the form of a walkover across the delineated site, broadly walking parallel to the contours of the hillside, which is more energy-efficient than walking up and down the slope. For the same reason, the walkover started at the top of the site along the north-eastern site boundary and traversed downhill between the two meltwater streams that flanked the site. Generally speaking, a traverse spacing of 1 m apart was aimed at but adjusted to local circumstances. DPGS readings were taken continuously at a spacing of ca. 0.5 m. The terrain was frequently difficult to traverse (local steepness, bogginess), so that some areas were sub-divided. Where sudden elevation changes were apparent, more data points were gathered; where the landscape changed more subtly, the traverses were spaced more widely to save time. At the coast, erosive process had created a steep and difficult shoreline that warranted increased attention.

Weather conditions during the survey were changeable, which had some influence on the task. Broadly speaking, Nobles was the only staff who was always on the move and therefore warm (stationary archaeological excavation and vegetation survey are much colder undertakings). However, spitting rain slowed the walkover because the ToughPad

reacted to raindrops hitting the touchscreen. This was solved provisionally by covering the ToughPad with a clear plastic bag.

3.2 3D photogrammetry

The photogrammetry was highly weather-dependent as it could not take place in heavy rain (damage to equipment; exposure of staff) or strong wind (difficult handling of telescopic pole; exposure). Nor would bright sun all day be good because of deep and wandering shadows in and around the features of interest. Since the weather in the Arctic must never be relied on, the photogrammetry was only a side note to the project, to take place if possible. It was one of the perks of working opposite Longyearbyen, however, that we had internet access and therefore daily weather reports that proved very accurate. The weather was favourable on Tuesday, August 9, 2016 (part sun, part cloud, 8.0°C, light breeze, 0.1 mm rain), and so the team set out to undertake the photogrammic building recording at Hiorthhamn. The walk of 2.5 km along the beach was slightly testing due to the need to carry bulky rather than heavy equipment like the dGPS case and its tripod.

The photogrammetry methodology followed the guidelines of the Agisoft PhotoScan User Manual (2016). The historical buildings of interest at Hiorthhamn had previously been identified by KRUSE (2014). Under the supervision of Gary Nobles, small reference markers compatible with the PhotoScan™ software were placed around each of the buildings and their positions recorded with the dGPS prior to the survey. To speed up the process, two cameras were used, a Canon D650 and a Canon D550, both with the following setting: ISO 100, F-stop F5.6, automatic-variable exposure time, focal length 18mm, and disabled flash. The photographers were instructed to sidestep around the buildings and take digital photographs at close range (max. 2 m) while making sure that each target was captured on at least three occasions with 80% overlap. The photographers also took distant shots at a range of ca. 10 m to ensure adequate coverage of each building and a chance of recording the high roofs. The use of the telescopic pole would have been possible in the light breeze, but it was found to be too time-consuming to achieve the accuracy needed.

Having made a good start at Hiorthhamn, Nobles could proceed with the photogrammetry at Advent City whenever weather and time permitted. He was able to judge these constraints on location and alternated with the ongoing topographic survey. At Advent City, photogrammetry prioritised the house foundations, the mine entrance, and the

ventilation adit. Each was considered an individual object and approximately ten reference markers were positioned and geolocated with the dGPS prior to photography taking place. Photos were taken as described above to get full coverage. Additional photos were taken dependent on the nature of the remains. The substantial ruins of the engine house, for instance, were a challenge. Furthermore, rapid close-range photogrammetry was applied to the terrain of the site, across which targets were laid out at regular intervals which could easily be captured by the camera and which were geolocated for later geo-referencing. This task was cut short by the polar bears.

3.3 Archaeological evaluation

In the project design, the *excavation strategy* initially envisaged the partial excavation of two middens and four "latrines". Partial excavation would evaluate the deposits while at the same time preserving the majority of this non-renewable resource for future investigations. Subsequently, the Governor of Svalbard favourably advised Norway's Directorate of Cultural Heritage, and permission was given to excavate **25% of midden M1**, **25 % of midden M2**, **50% of two "latrines"** of our choice.

The *excavation methodology* employed MOLA's (1994) Archaeological Site Manual and made use of the single-context planning system. Three small trenches were opened and a photographic and written record of each had been made by the time the polar bears showed up. The three trenches were:

1. **Trench M1** on midden M1 downslope of the stables 7b, a rectangular trench with final dimensions 1.90 m by 1.02 m
2. **Trench M2** on midden M2 downslope of the stables 7b, a triangular trench with final dimensions 2.15 m by 2.27 m by 4.88 m
3. **Trench Z1** in "latrine" Z1 in the vicinity of workers' barrack 5c, a roughly square trench of 0.7 m by 0.7 m.

The irregular shapes and sizes of the trenches came about in the following ways:

- Midden M2 was chosen to be investigated first. Previous fieldwork (KRUSE 2014) had found cut animal bones at the surface, so it was likely that a trench at this location would yield the sought-after bone material. Because midden M2 was a roughly circular deposit, **trench M2** was placed and opened according to a traditional

quadrant method, which would allow 25% of the midden to be exposed while at the same time being able to extend the search for the edge of the deposit outwards. This method worked well but resulted in the slightly awkward shape and dimensions stated above.

- Trench M2 instantly yielded so many animal bones, however, that there was a great risk of overstretching the post-excavation budget if the other trenches contained a similar amount of finds. **Trench M1** was therefore kept small and did not cover the permitted 25% of midden M1. The option of extending the trench was not made use of in view of the polar bears.
- With the choice of two of the four "latrines", the team decided to focus on the two features which were most easily accessible, i.e. those that stood relatively free and had the least wooden planks and other material (in danger of being disturbed and even broken in the excavation process) lying around them. Z1 and Z4 were chosen, but only **Z1** was investigated in the reduced time available. It quickly became clear that it was in fact domestic ash that had been purposefully dumped into a wooden box (see section 4 below). The dimensions of the 'trench' are therefore the dimensions of the interior of this box. The box had been placed directly on the ground, and there was nothing to be gained from removing it to see what was underneath. The wooden floor of the box constituted the bottom of the trench.

Prior to the excavations taking place, each feature was investigated by ***hand-coring***. The cores were photographed. The discovery was partial in all cases. Only one bone fragment was found in one of the cores of midden M2. The results were not diagnostic and did not change the planned methodology.

Once trench M2 had been de-turfed, it was searched with a ***metal detector***. Every detection was marked with a survey flag, but no pattern emerged. At closer inspection, the majority of the detections were iron nails. Metal detecting was found to be time-consuming and non-diagnostic. It was not repeated for the other trenches and did not influence the planned methodology.

Historical sources (KRUSE 2016a) had given rise to the assumption that the middens and the ash dumps primarily represented the human activity of dumping waste in assigned locations over a very limited period of time between 1904 and 1908, in some cases even

shorter. Based on this and in light of a research focus on overall environmental impact, it was decided to treat the dumping of waste as one event and to excavate the resultant waste deposits as a single contexts rather than split them into the many small dumping occasions, which may or may not have been discernible still. Subsequently, the trenches were ***excavated by trowel*** in 5-cm spits. These spits were photographed at regular intervals. Drawing was to be kept to a minimum of section drawings at the end of the excavation. Bear-dependent, drawing never took place. However, Nobles was able to record the trenches with 3D photogrammetry.

Environmental archaeological sampling was undertaken to provide primarily environmental data but also additional economic and behavioural information. The kinds of animal remains expected at Advent City were large mammal bone, small mammal bone, bird bone, and fish bone (incl. scales and otoliths), and to a lesser extent molluscs, insect remains, as well as parasite eggs and cysts. Targeted plant remains were grain, chaff, seeds, leaves, and pollen. The research questions saw no immediate uses for charcoal or wood samples. The large remains visible to the naked eye were immediately hand-collected. Further strategy envisaged the collection of 20-ltr bulk samples and column samples (monolith tins) from each trench. The bulk samples were to be taken by hand-shovel from across the most appropriate undisturbed section after excavation and section drawing were completed. Again due to the polar bears, the sampling was rushed and strongly reduced:

- ***trench M1:***
    - *2 x 12-ml pollen sample*
    - *1 x 10-ltr bulk sample*
- ***trench M2***
    - *2 x 12-ml pollen sample*
    - *1 x 10-ltr bulk sample*
- ***trench Z1:***
    - *2 x 10-ltr bulk sample*.

The environmental samples were sealed against loss of moisture but otherwise untreated. They were sent to the Groningen Institute of Archaeology (GIA) of the University of Groningen (RUG) in the Netherlands (for transport arrangements and duration, read on).

The general ***finds collection*** policy was to collect all finds including unstratified animal bone and shell with the exception of building material such as wood, brick, or

concrete. The team systematically collected inorganic materials in the form of metal (excluding slag), glass, and a single ceramic shard. They also systematically collected organic materials in the form of probable leather, fibre, hair, bone, antler, and seeds. A combination of materials occurred only once in the shape of a broken broom (wood and fibres). All finds were packed by material in unpunctured polythene bags, no additional treatment. The bags were gathered in large aluminium boxes and transported back to GIA in the Netherlands on deck of a cruise ship at air temperature. This temporary storage and transport took between August 16 (packing in Svalbard under Arctic conditions) till October 6, 2016 (arrival at GIA in mild autumn weather, unpacking, beginning of conservation).

4. Interim statement on the results of fieldwork

4.1 Topographic survey using dGPS

Fig. 4.1 is an overview of the results of the topographic survey of the site at Advent City.

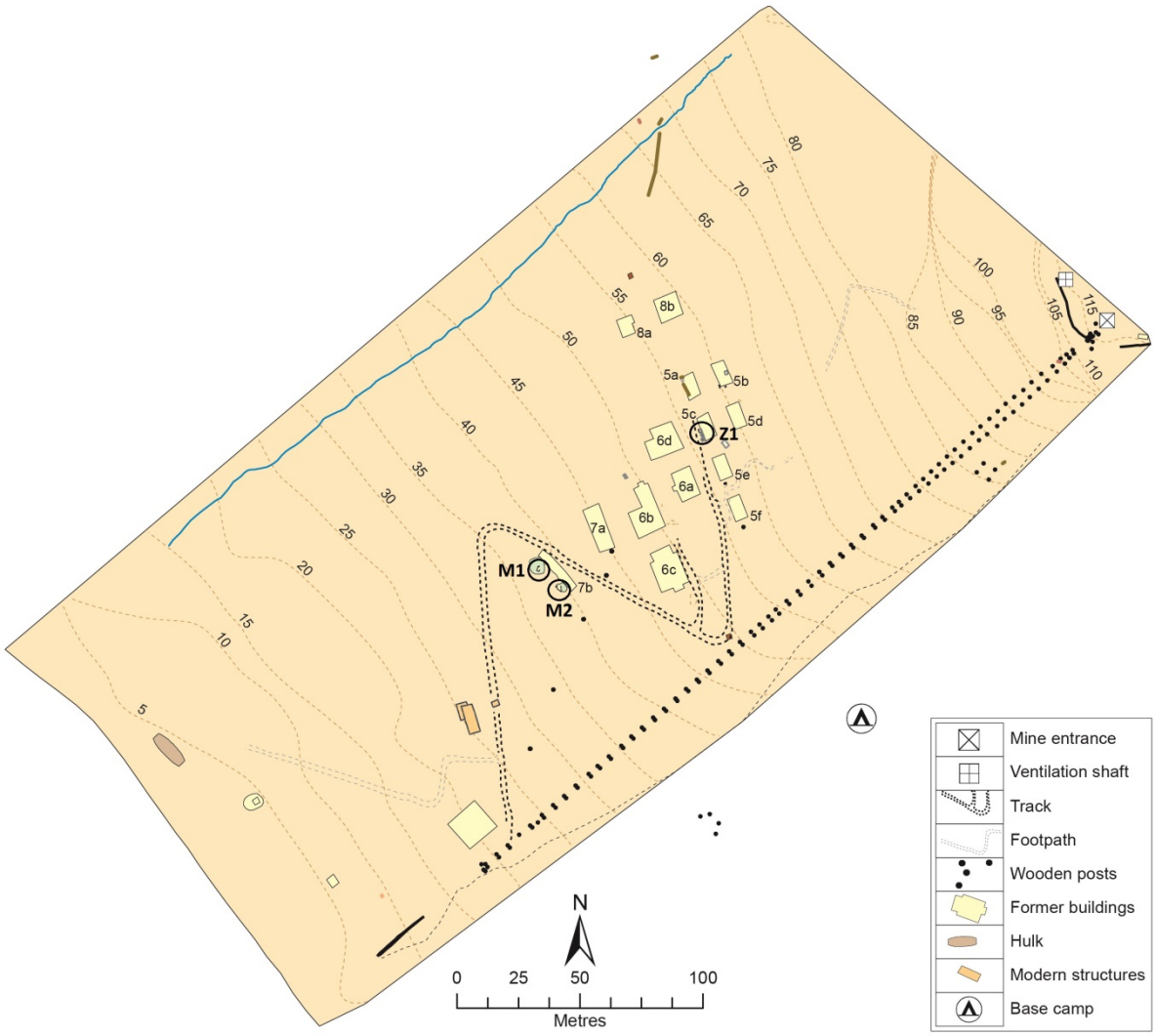

Fig. 4.1 An overview of the results of the topographic survey at Advent City using dGPS. The small circles mark the middens M1 and M2 as well as the domestic dump Z1, where the archaeological excavation of small evaluation trenches took place. (Map courtesy of Gary Nobles.)

At this scale, many of the small details surveyed (e.g. latrines, fox traps, the grids of the vegetation survey) are of course not visible. At first sight, it may appear that a similar result could have been obtained by simply combining the geospatial data of the topographic map (**Fig. 1.6**), the aerial photograph (**Fig. 1.7**), the LASHIPA expedition of 2004 (KRUSE 2013) and the Governor's official archaeological survey in 2012 (FOOSNÆS 2012). The strength of this

survey, however, lies in calibrating the satellite imagery with the situation on the ground and in closing important gaps in the archaeological record while at the same time making significant contributions to the interpretation of the site and its presentation to a wider audience (see section 4.2 below). It is unfortunate, therefore, that the survey of the ropeway towers and the spoil heaps at the ropeway terminal (preliminary interpretation) could not be completed.

Map features to note include:

- for the first time, a survey at Advent City has been expressly delineated, in this case using dominant natural boundaries around the site. The full extent of the meltwater streams and other prevailing slope processes, however, is still much clearer in the aerial photograph;
- the topographic contours in **Fig. 1.6** and **Fig 4.1** correspond fairly well, although in the latter, there appears to have been past slumping of the slope in the north corner of the site;
- the majority of buildings at Advent City have clearly been positioned away from the immediate dangers of the meltwater streams and parallel to the prevailing contours;
- the stables (7b) break with the alignment of the rest of the settlement while still being parallel to the local contours: this may partially have been caused by the relatively late construction date (probably winter 1906/7 and summer 1907);
- the winding of tracks and paths across the steep slope allowed for more energy-efficient access into the settlement and up to the mine (they still do!); bends seem to occur with every 15 or so metres of height gained;
- the modern hut has not been built parallel to the contours but alongside the historical track, making use of this access arrangement. The associated shed was built directly onto the track, effectively cutting it off: there has apparently not been a modern use for a track up to the ruins;
- KRUSE'S (2014) previous work at both Advent City and Hiorthhamn provided very detailed measurements for most of the house plans at Advent City: these measurements were employed during this survey, getting rid of earlier estimates and generating an accurate map of the settlement;

- erosive action along the shore has made it very difficult to discern historical features and activities here.

4.2 3D photogrammetry

While the topographic survey of the site was an integral part of the fieldwork, 3D photogrammetry was treated as a side note, albeit an important one, to be pursued if time and weather permitted. Under favourable conditions, Gary Nobles was able to test the application of the technique in Arctic archaeology. He photographed the archaeological structures and most of the terrain at Advent City as well as those buildings at Hiorthhamn which are known to have originated from Advent City (KRUSE 2014). The resultant dataset is very large. It forms the basis of an entirely separate research and heritage-management project, for which funding has now been secured (Svalbard Environmental Protection Fund project no. 16/64). This report merely provides a brief indication of the technique's potential for Svalbard.

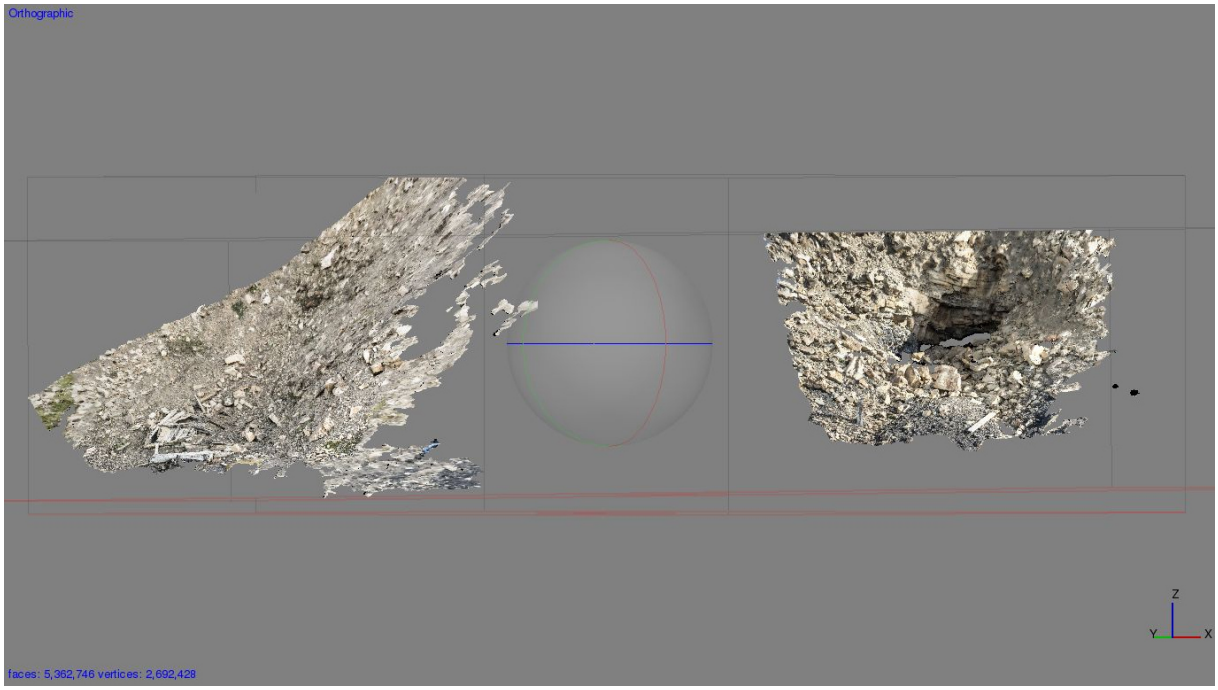

Fig. 4.2 Screen shot of an interactive 3D image of the collapsed ventilation shaft (left) and mine (right) at Advent City. (Courtesy of Gary Nobles.)

In the first instance, photogrammetry allows for features to be recorded and represented beyond the limitations of ordinary survey and 2D photography. **Fig. 4.2**, for example, is a screenshot of an interactive 3D image of the former mine and ventilation adit.

Furthermore, **Fig. 4.3** shows just one of the houses at Hiorthhamn which formerly stood at Advent City. Using the now accurate map of Advent City and depending on future funding, it will be possible to virtually place these buildings back in their former positions and to generate an interactive 3D view of the historical mining settlement. Besides constituting an important research and heritage-management tool, 3D imagery in the form of annotated panoramic views and fly-through videos could also be of interest to the education sector and the tourism industry among other end-users.

Fig. 4.3 Screen shot of an interactive 3D image of a building at Hiorthhamn which originally stood at Advent City. (Courtesy of Gary Nobles.)

4.3 Archaeological evaluation

As stated in section 3.3 above, three small trenches were excavated at Advent City. The results of the excavation are tabulated and visualised in this section.

TRENCH M1	On midden M1 downslope from building 7b. Rectangular with final dimensions 1.90 m by 1.02 m.			
CONTEXT	DESCRIPTION	FINDS	SAMPLES	INTERPRETATION
100	deposit; dark brown organic-rich silty fine sand with occasional gravel, grass cover, many rootlets, even thickness of ca. 5 cm	none	12 ml for palynology	naturally grown **topsoil and tundra vegetation**; represents soil formation since site abandonment in **autumn 1908**
101	several deposits treated as one context; variable from light brown organic matter (hay, straw) to medium to dark brown sandy layers to black coal and charcoal and dark grey ash; lowest sub-layer clearly of hay/straw with horse dung; frequent rootlets until patchy permafrost sets in, esp. at N end of trench; variable thickness, max. ca. 40 cm	few but variable, bone glass, metal (nails, cans, wire), wood, leather, rope, printed paper (newspaper or book), hair, seeds	3 finds bags of dung, all bones, 10-ltr bulk sample: for palaeobotany, zooarchaeology, and microbiology/ parasitology	layers of refuse: **a midden**; bottom layers clearly from a **horse stable**; top layers uncertain: did hay and straw run out? did the building change function? did it have its own stove or did the charcoal and ash come from elsewhere? the building first appears on a photo from winter 1906/7 (spring 1907): the midden is thought to have been in use **from winter 1906/7 till autumn 1908**
102	deposit; dark lead grey firm sandy clay/silt with many inclusions; inclusions of angular cobbles of sedimentary bedrock and wood cut-offs; occurrence of permafrost under cut-offs, some rootlets; variable thickness, max. ca. 10 cm	few wood cut-offs, iron nails	none	layer represents **construction of horse stable**; re-worked ground from blasting/digging postholes, cut-offs from constructing wooden building; thought to date from **winter 1906/7**
103	deposit; inconspicuous layer of dark brown-grey silty sandy clay; overlooked during excavation; variable thickness, max. ca. 3 cm	none	12 ml for palynology	**buried topsoil and tundra vegetation**; buried during construction of horse stable, **pre-dates winter 1906/7**
104	deposit; dark lead grey clayey sandy silt with frequent angular cobbles of sedimentary bedrock	none	none	**natural soil**
spoil	spoil heap shows clear differences in colour and consistency between midden and natural soil	those finds overlooked during excavation	none	
FINAL INTERPRETATION	Historical sources (KRUSE 2016a) suggest that building 7b was constructed in two parts (or the original was extended) and that the part associated with midden M1 is the earlier one of the two constructed in winter 1906/7. In trench M1, the oldest anthropogenic layer is the construction layer. This is followed by a thick wad of hay, straw, and horse dung, which suggests a first function as horse stables. However, later deposits comprise much less hay and straw and more charcoal and ash – it has not been able to interpret these. **The stable and midden have been in use between winter 1906/7 and the company's site abandonment in autumn 1908.**			

Fig. 4.4 Overview of Trench M1, showing contexts 100 (topsoil with tundra vegetation), 101 (midden), and 102 (construction layer). Contexts 103 (buried topsoil) and 104 (natural soil) are not visible. (Photo: F. Kruse 2016.)

Fig. 4.5 South-facing section of Trench M1, showing contexts 100 (topsoil with tundra vegetation) and 101 (midden). (Photo: F. Kruse 2016.)

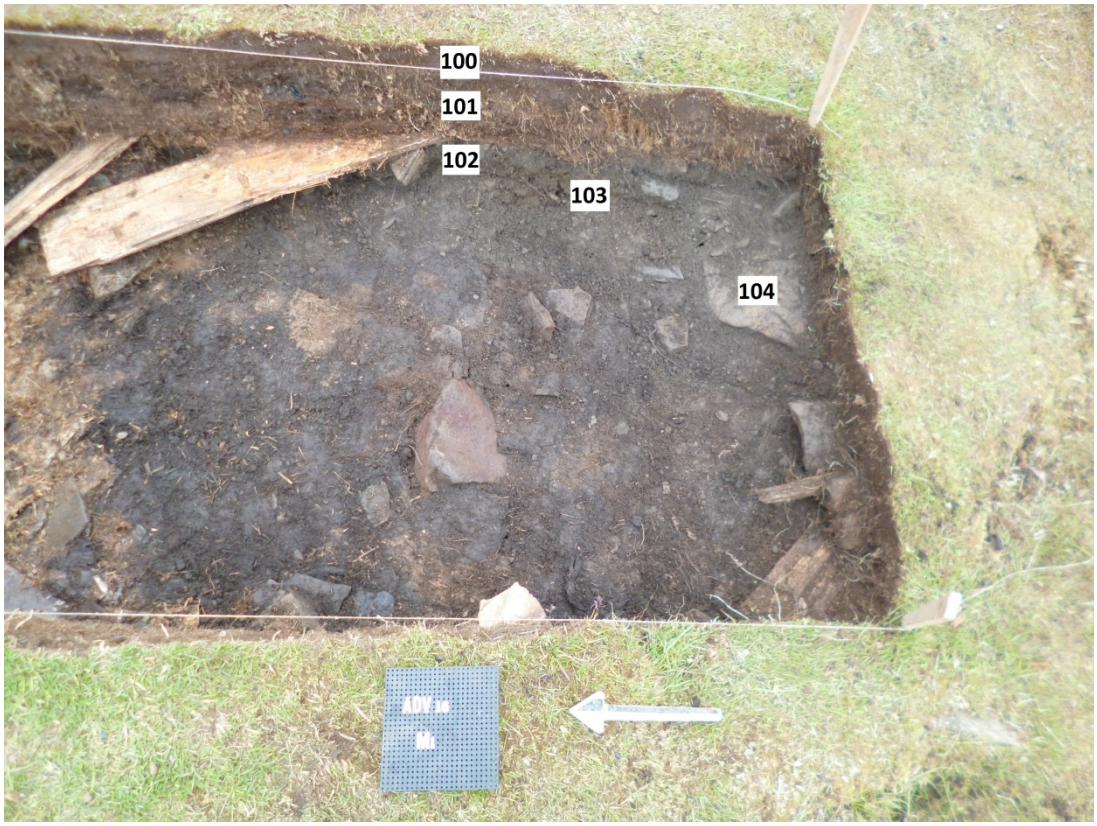

Fig. 4.6 West-facing section of Trench M1, showing contexts 100 (topsoil and tundra vegetation), 101 (midden), 102 (construction layer), 103 (buried topsoil: this is the inconspicuous red-brown colour in both section and plan view), and 104 (natural soil: lead-grey in colour). (Photo: F. Kruse 2016.)

Fig. 4.7 Spoil of Trench M1, showing obvious colour differences between the light anthropogenic and dark natural contexts. (Photo: F. Kruse 2016.)

TRENCH M2	On midden M2 downslope from building 7b. Triangular with final dimensions 2.15 m by 2.27 m by 4.88 m.			
CONTEXT	DESCRIPTION	FINDS	SAMPLES	INTERPRETATION
200	deposit; dark brown organic-rich silty fine sand with occasional gravel, grass cover, many rootlets, even thickness of ca. 5 cm	none	12 ml for palynology	naturally grown **topsoil and tundra vegetation**; represents soil formation since site abandonment in **autumn 1908**
201	several deposits treated as one context; capped by a layer exclusively of large mammal bones (predominantly cut vertebrae and ribs), then variable light brown to brown silty and sandy with frequent gravel- and cobble-size inclusions, firm to stiff; abundant roots and rootlets but also many plant stalks; ca. 20 cm thick	much mammal bones (most likely cattle) and other bone including reindeer and fish, metal (nails, cans, wire), some glass, a single ceramic shard, a broken broom, many plum seeds	all bones, 10-ltr bulk sample: for palaeobotany, zooarchaeology, and microbiology/ parasitology	layers of refuse: **a midden**; capping layer appears to be the remains of 'fresh beef' brought to site to feed the miners after the strike in spring 1907; interpretation of other layers uncertain: could this be the remains of pig feed and amorphous pig dung – **a piggery**?; this part of the building is absent from a photo from winter 1906/7 (spring 1907) but present in one from summer 1908; the midden is thought to have been in use **from spring/summer 1907 till autumn 1908**
202	deposit; dark lead grey firm sandy clay/silt with many inclusions; inclusions of angular cobbles of sedimentary bedrock and wood cut-offs; some rootlets; variable thickness, max. ca. 15 cm	few wood cut-offs, iron nails	none	layer represents **construction of a stable**; re-worked ground from blasting/digging postholes, cut-offs from constructing wooden building; thought to date from **spring/ summer 1907**
203	deposit; layer of medium to dark brown silty sandy clay; variable thickness, max. ca. 3 cm	none	12 ml for palynology	**buried topsoil and tundra vegetation**; buried during construction of stable, **pre-dates spring/summer 1907**
204	deposit; dark lead grey clayey sandy silt with frequent angular cobbles of sedimentary bedrock; very wet as probably in active layer of the permafrost	none	none	**natural soil**
spoil	spoil heap shows clear differences in colour and consistency between midden and natural soil	those overlooked during excavation, also construction waste (cobbles and cut-offs)	none	
FINAL INTERPRETATION	Historical sources (KRUSE 2016a) suggest that building 7b was constructed in two parts and that the part associated with midden M2 is the later one probably constructed in spring/summer 1907. In trench M2, the oldest anthropogenic layer is the construction layer. This is followed by a fairly amorphous layer that may point to a piggery. The last layer to be added to the midden before it grew over comprised mostly cut bone, probably cattle, 'fresh beef' having been brought to site after the workers' strike in spring 1907. **The stable and midden have been in use between spring/summer 1907 and the company's site abandonment in autumn 1908.**			

Fig. 4.8 Overview of trench M2, showing all five contexts (see below). (Photo: F. Kruse 2016.)

Fig. 4.9 North-facing section of Trench M2, showing contexts 200 (topsoil and tundra vegetation), 201 (midden), 202 (construction layer), 203 (buried topsoil: red-brown in colour), and 204 (natural soil). (Photo: F. Kruse 2016.)

Fig. 4.10 Spoil of Trench M2, showing obvious colour differences between the light anthropogenic and dark natural contexts. (Photo: F. Kruse 2016.)

Fig. 4.11 The finds of trench M1, context 101 (midden) with the omission of animal bones and seeds. (Photo: F. Kruse 2016.)

TRENCH Z1	In feature Z1 in the vicinity of building 5c. Roughly square with approximate dimensions 0.7 m by 0.7 m.			
CONTEXT	DESCRIPTION	FINDS	SAMPLES	INTERPRETATION
300	deposit; dark brown organic-rich silty fine sand with occasional gravel, a whitish 'coating' (fungus, lichen, chemical?) and surprisingly little vegetation, even thickness of ca. 5 cm	none	none	naturally grown **topsoil and tundra vegetation**; represents soil formation since site abandonment in **autumn 1908**
301	several deposits treated as one context; two main sub-layers; top sub-layer red- to chocolate-brown clayey-silty sand with frequent gravel-size inclusions of charcoal, unlike topsoil very many roots and rootlets throughout; bottom sub-layer of ash, predominantly light grey, like gravelly sand with inclusions of coal, stone, slag	unburnt bone in the top sub-layer, frequently bird (probably ptarmigan), some fish; burnt bone in bottom sub-layer; metal (nails, cans, wire, lamp holder), a bone caught in a wire, glass , leather, printed paper (newspaper or book)	all bones, 20-ltr bulk sample: for palaeobotany, zooarchaeology, and micro-biology/ parasitology	domestic refuse, in the first instance a **domestic ash dump**, subsequently either different fuel or different source of refuse; associated with building 5c and thought to date **from summer 1905 till autumn 1908**
301	structure; remains of a box; sides and bottom made from wooden planks, no cover; approximately 1.5 m by 0.7 m	n/a	none	wooden box built for the purpose of holding **domestic refuse,** in the first instance domestic ash; structure tightly associated with **building 5c**: a barrack for the workforce built in summer 1905; in use **from summer 1905 till autumn 1908**
FINAL INTERPRETATION	Feature Z1 is too small and was probably too insignificant to have been captured in the historical sources. It and others like it are, however, structurally associated with building 5c, which has been interpreted as a barrack for the largely Scandinavian (Norwegian) workforce. Built in summer 1905 (KRUSE 2016a), the barrack was one of the earliest company buildings on the site. The initial function of Z1 appears to have been as an ash dump (not a latrine); if not cooled properly, hot ash so close to the wooden house would have been a safety hazard. Evidence as to the household is scarce. The rooms were lit by an unknown fuel (oil? carbide?). Burnt bones hint at a small-scale consumption of large mammals (or was the bone worked?). Unburnt bones hint at a small-scale hunt and/or consumption of birds (ptarmigan?) and fish. There may have been leather working. There may have been reading (as opposed to just lighting the fire with paper). The slag may have formed accidentally. What caused the change from an ash dump to a more general dump? **The workers' barrack and the domestic ash dump were in use between summer 1905 and the company's site abandonment in autumn 1908.**			

Fig. 4.12 Trench Z1 during excavation, showing contexts 300 (topsoil), 301 (domestic refuse in brown top sub-layer and a grey bottom sub-layer), and 302 (the wooden box the refuse is contained in). (Photo: G. Nobles 2016.)

Fig. 4.13 Trench Z1 after excavation, same contexts as above. (Photo: G. Nobles 2016.)

Fig. 4.14 A special find from trench Z1, context 301 (domestic refuse): this has preliminary been interpreted as a bird (probably ptarmigan) held by a metal wire. It is not known if the bird was still alive and kept as either as a pet or live food store or whether it was already a dead food store. (Photo: G. Nobles 2016.)

4.4 Additional field observations

In section 1.3 above, historical evidence for human activities that may have had a lasting impact on the local environment at Advent City has been listed. **Table 4.1** below reiterates this evidence and builds on the list by adding relevant field observations.

Historical evidence (KRUSE 2016b)	Field observations
people	Advent City is clearly the result of human presence in the Arctic. Mining was of a transient commercial activity between summer 1905 and autumn 1908.
ground-levelling	clearly visible as building foundations, working platforms, tracks; *further investigation during vegetation survey*
mining	former mines collapsed and inaccessible; mining evident at pithead and in transportation (ropeway, incline)
stockpiling	remains visible at bottom of ropeway and of incline, to lesser extent around workers' barracks
seals	probable seal bones found in Trench M2; *further investigated during bone analysis*
quarrying	 beach pebbles are round; these angular pebbles were produced on site for use of aggregates in concrete (photo F. Kruse 2014)  sandstone boulders across the site were quarried for building material (blocks and aggregates) by plug-and-feather method

Historical evidence (KRUSE 2016b)	Field observations
reindeer	reindeer antler found in Trench M2; *further investigation during bone analysis*
paraffin, oils, carbide	 barrels of carbide at building 6c and engine house 9 (photo F. Kruse); a lamp holder for an unknown fuel found in Trench Z1
horses, pigs, dogs, goat	horse dung found in Trench M1;  possible pig trough at stables 7b (photo F. Kruse); *further investigation during bone analysis*
foxes	 fox traps set out across the site (photo F. Kruse);

Historical evidence (KRUSE 2016b)	Field observations
	 fox traps manufactured at building 6c (photo F. Kruse); *further investigation during bone analysis*
hunting huts	off site, not investigated
damming	no signs of damming, probably washed away; possible small pumping station near building 8c;  water pipes from high up on both streams into the settlement (here building 6c, photo F. Kruse) as far down as engine house 9
hay and straw	hay and straw found in Trench M1; *further investigation during palaeobotanical analysis*
stockfish/fish	fish bones found in both trenches; *further investigation during bone analysis*

Historical evidence (KRUSE 2016b)	Field observations
waste	midden excavated in trenches M1 and M2; domestic ash dump excavated in Trench Z1;  more ash dumps exist across settlement, here near building 6b (photo F. Kruse)

Table 4.1 Historical evidence (KRUSE 2016b) substantiated by field observations.

Furthermore, the archaeological walkover at Advent City yielded a range of new impressions which have preliminarily been interpreted in **Table 4.2** below. These observations were made at the surface only; no probing, coring, or digging of any kind took place to verify them. All photographs taken by F. Kruse.

Field observation	Preliminary interpretation
	The stone pillars in the back form the foundation of workers' barrack 5c – one of the last buildings to be built in Advent City. It was put up in summer 1907 (KRUSE 2016b).

Field observation	Preliminary interpretation
	Posts buried in permafrost eventually show the influence of slope processes such as soil creep: with its base still anchored in ice, the upper part of the post tilts downhill under the forces in the active layer
	Central to the picture are a number of large, ca. 10-cm thick concrete slabs. Stable 7b appears to have had a concrete floor, but only the west end of it. This end was associated with midden M1 and the horse dung. In view of no other building having had a concrete floor, why would the horses have been stabled on concrete? It seems that the straw was used up quickly or that it perhaps was not used in summer. The concrete may have been a measure to keep the horses warm and/or their hooves healthy.
	At least 8 of these buckets have been found across the site, all used for target practice. Why were the buckets not re-used? It is thought that these buckets were used in the human latrines and were therefore not an item to be re-used voluntarily.

Field observation	Preliminary interpretation
	There is a historical photo (KRUSE 2016b) of such wooden carriages being used with the first aerial ropeway on site, which dates to 1903. **This item should be restored and kept safe in at the Svalbard Museum!**
	The general assumption is that birch bark was used to insulate houses. Yet the buildings at Advent City were pre-fabricated. Did they still require birch-bark insulation? Or was birch bark also used for tanning hides and leather, not necessarily at Advent City but on Spitsbergen as a whole?
	Very likely the primary claim sign of the Spitzbergen Coal and Trading Company Ltd. It has not received enough attention in earlier studies but was mapped properly during this fieldwork. The claim sign would have been positioned at the spot where visitors to the site were most likely to arrive (naturally or as dictated by the company). It is therefore very important as a point of departure in the spatial analysis and interpretation of the site.

Field observation	Preliminary interpretation
	Several rails, mostly bent, have been found across the site and at considerable height, yet it has not been possible to find any kind of earthworks associated with a track. Railway track were probably temporary and only laid to assist in the immediate transport of bulky equipment and goods. How were the rails bent? Were they used as levers? It is not known if and how rail-assisted manpower and horse-power complemented each other.
	Several broken bottles were found across the site (not associated with any particular building). A whole one has been taken to the Svalbard Museum. The over-indulgence of the workforce in alcohol and subsequent unruly behaviour are commonly listed as a reason for the strike in spring 1907.
	The latrines appear to have been free-standing sheds, in this case with two cubicles, using buckets. It is not known if the management had a different arrangement, i.e. interior toilets, who emptied the buckets and where, and if the buckets froze in the winter and presented a problem.

Field observation	Preliminary interpretation
	Why are there relatively many stoves and stove parts left at Advent City? Were there many more than represented by these remains? Were they no longer in working order? Did everyone else already have enough stoves? Were they an easy and cheap item to replace?
	The ground continues to move at Advent City.
	Not only was the manager's house the only one with brick foundations; it also had under-house storage. The picture is of a door below the building.

Field observation	Preliminary interpretation
	Besides buckets and stoves, another relatively frequent find were leather shoes, one of the extremely rare personal items on site.
	Building 8b most likely functioned as a club house. The remains seem to have been affected by flooding or a landslide.
	None of the historical sources show a building at this location. It is likely that the concrete foundations were poured, but 'building' 8a was never erected. On the note of concrete foundations: there were by no means unique to Advent City; Old Longyear City had them as well (Reymert 2013), but after the settlement had been destroyed during WWII, the foundations were probably crushed and re-used a aggregates elsewhere.

Field observation	Preliminary interpretation
	To the west of the settlement below buildings 8a and 8b, there are several assemblages of domestic refuse. It is not known if these assemblages constitute the general dump of the settlement or if the items have been brought here by the flood or landslide suggested above or have even been transported by strong winds.
	A wooden box in the vicinity of barrack 5e not only contained the workers' apparent coal supply; it also included bits of worked antler, metal, leather, some broken glass… These items are thought to represent the workers' household. Small-scale working of bone, metal, and leather may have occurred either for private use, as presents to family and friends or even to sell to tourists on site or back at home. Besides these items, it has been very difficult to discern evidence for the household and the life of the workers on site.
	During an earlier visit to Hiorthhamn, KRUSE (2014) overlooked this building: it is a former workers' barrack from Advent City, and it was probably brought to Hiorthhamn prior to any other building based on the fact that Hiorth used it as his claim hut (see below). The choice of foundation is the same solid stone pillars which supported workers' barrack 5d at Advent City. Recently, the foundations have been renewed, moving the building a few metres forward.

Field observation	Preliminary interpretation
	The fading text on the above house at Hiorthhamn reads '[…]ck Hiorth Eiendom'. It clearly marks it out as Hiorth's claim hut.
	These remains are eroding into the sea at Hiorthhamn. They are most likely parts of an Anderstons vertical gas engine from Glasgow dating back a century. **The authors strongly suggest that these and other industrial remains at risk be taken to the Svalbard Museum (or Mine No. 3) for conservation and safe-keeping. Such remains may well be the last of their kind in the world and form an important milestone in the industrialisation and settlement of Svalbard.**

Table 4.2 New field observations, in no particular order, and their preliminary interpretation.

Despite the many items listed in the tables above and despite their varied nature, the overall impression of the archaeological team is nonetheless that **the site is incredibly clean and tidy**. That is to say that by the time the Spitzbergen Coal and Trading Company abandoned Advent City, they had either already re-purposed much of their equipment and provisions, or those who outlasted them (winter watchmen, the Arctic Coal Company, Hiorth's new company, and others) did a very good job of salvaging the buildings (see KRUSE 2014) and just about everything in and around them. This impression makes items that have been left on site, such as the three huge gas engines in the engine house or the coal cutter below the mine, all the more intriguing. Were they such a poor, useless choice that no one else in the Arctic had a use for them?!

5. Summary of the site archive and work carried out for assessment

5.1 Site record

To assist with the management and the full recording of the site, a site file was kept during the fieldwork at Advent City. At the time of writing this fieldwork report, the field records had been checked by Frigga Kruse, and the site file contained the following data (numbering refers the code of recording forms):

- A1 site register
- A2 visitors record book
- A3 daily site record
- B4 context index
- B7 photographic indices and contact sheets (per photographer, but excluding extensive photogrammetry data)
- B8 sample and small finds codes (i)
- B9 sample index
- B10 small finds index (i)
- C12 context recording sheets
- C13 soil sampling sheets
- C14 environmental sampling sheets
- C19 trench recording sheets
- C20 assemblage summary sheets (i)
- D21 project design
    - site location & proposed trench plans
    - permission Riksantikvaren
    - agreement Svalbard Museum
    - registration sub-project RiS ID 10597 (vegetation survey)
    - project planning
- D22 site safety plan
    - Field safety in Svalbard (n)
    - Guidelines for firearms (n)
    - permit to hire a rifle

    - certificate of conduct
    - risk assessment
- D24 site inspection record
- D25 site completion record
- D26 equipment list
- E27 sample transmittal form
- E28 sample receipt form
- In addendum
    - Archaeological site manual (MOLA 1994)
    - Environmental archaeology guide (Historic England 2011)
    - Animal bones and archaeology. Guidelines for best practice (Historic England 2014)
    - outreach and publicity

In these site file contents, (i) stands for 'incomplete' and indicates that the soil samples (see below) were still being processed and that there was still a possibility of discovering additional small finds which would need to be added to the indices. The majority of the site file had already been converted to a PDF (KRUSE 2016c), to be updated once the small finds indices were complete. (n) stands for 'not included in the PDF'.

The site file PDF was disseminated to the archaeological team, the botanists, the archaeological specialists who would be doing the environmental analyses, and the polar heritage managers of Svalbard and Norway. Copies were uploaded on the Research in Svalbard (RiS) Database, on ResearchGate, and on Academia. The completion of the site file and public access to it was advertised on the project's public Facebook page 'Polar bear says' as well as the closed Facebook group 'Gamle Svalbard'.

5.2 Finds

Finds are broadly understood to be manufactured artefacts as opposed to (manipulated) ecofacts that hold environmental information. The latter will be listed in the section below. At the time of writing, the small finds listed in **table 5.1** had been hand-collected either during the excavation or during the processing of the soil samples:

Context	Finds (manufactured artefacts)
100	none
101	finds generally rare; rare broken glass, some metal (iron nails, wire, degraded tin cans), some wood cut-offs, rare probable leather as cloth and cut-offs, single piece of rope, bits of printed paper (newspaper or book in a Scandinavian language)
102	frequent wood cut-offs (not collected)
103	none
104	none
200	none
201	finds more frequent than in trench M1 but still scarce; rare broken glass also from measuring jug, some metal (ca. 60 iron nails of different sizes, wire, tin cans, a large nut), some wood cut-offs, rare leather cut-offs, a broom with bristles
202	frequent wood cut-offs (none collected)
203	none
204	none
300	none
301	few finds for a domestic dump; rare broken glass, rare iron nails, wire, slag, two leather straps, bits of printed paper (newspaper or book in a Scandinavian language); of interest are a small bone in a wire (probably to fasten the live or dead bird) and a lamp holder for an unknown fuel (carbide?)
302	this context is a wooden box (not collected)

Table 5.1 List of hand-collected small finds per context.

None of the finds were judged to be particularly diagnostic for the environmental purposes of this project. The plan is therefore to get them conserved at the Groningen Institute of Archaeology (GIA) of the University of Groningen (RUG) in the Netherlands as soon as possible (in-house specialist Gert van Oortmerssen, e: g.j.m.van.oortmerssen@rug.nl) and then to return them to the Svalbard Museum, who will catalogue and archive them for future reference.

Depending on time and money, the heavily degraded tin cans may yet be analysed using **XRF (X-ray fluorescence)**. XRF is a non-destructive analytical technique used to determine the elemental composition of materials. To further the discussion of lead poisoning probably leading to the demise of past Arctic expeditions, it would be interesting to know if these cans contained lead, and if so, how much. Perhaps Arctic miners on a poor diet were detrimentally affected.

5.3 Environmental material

Environmental sampling aimed for the systematic recovery of ecofacts that would yield diagnostic environmental data as well as economic and behavioural information. Cut animal bones, probably butchery waste, were treated as ecofacts as were burnt bones and seeds. At the time of writing, the soil samples and dung samples listed in **table 5.2** were already being processed for their respective analyses.

Context	Sample	Observation
100	soil sample, 12 ml	recent topsoil and tundra vegetation
101	hand-collected bones and seeds; soil sample, 10 ltr; dung (straw, hay, horse dung), ca. 5 ltr	midden comprising animal bone, animal hair, seeds, straw, hay, and horse dung
102	none	-
103	soil sample, 12 ml	buried topsoil and tundra vegetation
104	none	-
200	soil sample, 12 ml	recent topsoil and tundra vegetation
201	hand-collected bones and seeds; soil sample, 10 ltr	midden comprising animal bone, seeds
202	none	-
203	soil sample, 12 ml	buried topsoil and tundra vegetation
204	none	-
300	none	-
301	hand-collected bones and seeds; soil sample, 20 ltr	domestic dump comprising animal bone
302	none	

Table 5.2 List of environmental material and soil samples per context.

The small soil samples (ca. 12 ml) from contexts 100, 103, 200, and 203 were taken for **palynological (pollen) analysis** at GIA (in-house specialist Dr Mans Schepers, e: mans.schepers@rug.nl). The leading questions are:

1. What plant species are present in each sample?
2. Is there a significant difference between the former topsoil (pre-1907) and the present topsoil? And if so, why?

The hand-collected bones and soil samples from contexts 101, 201, and 301 were taken for **zooarchaeological analysis** at GIA (in-house specialist Dr Canan Cakirlar, e: c.cakirlar@rug.nl). The leading questions are:

3. What animal species are present in each sample?
4. What can the assemblages tell us about
    a. historical environment (pre-1908)
    b. animal biogeography
    c. past human behaviour
        i. diet
        ii. animal management
        iii. seasonality of exploitation
        iv. carcass processing
        v. pets and pests

vi. ritual and religion?

Depending on time and money, animal bones of different species will be selected on the basis of likely habitat and diet to undergo **C14 dating and isotopic analysis** at the Centre for Isotope Research at the RUG (specialist Prof. Hans van der Plicht, e: j.van.der.plicht@rug.nl). The leading questions are:

5. Do the selected bones date back to the likely time of death of the animals, that is to say 1907 and 1908? And if not, why not?
6. Can the animal bones from Advent City be used as a data point in the quantification of the marine reservoir effect in Svalbard?

The soil samples from contexts 101, 201, and 301 as well as the dung samples from context 101 were taken for **palaeobotanical analysis** at GIA (in-house specialist Dr Mans Schepers, e: mans.schepers@rug.nl). The leading questions are:

7. What plant species are present?
8. What can the assemblages tell us about
    a. historical environment (pre-1908)
    b. plant biogeography
    c. past human behaviour
        i. diet
        ii. animal management
        iii. seasonality of exploitation
        iv. pests
        v. ritual and religion?

5.4 Documentary records

This section usually provides a list of relevant documentary sources discovered, their quantity and variety, and the intensity with which these sources were studied during the post-excavation assessment. However, as mentioned in section 1.3 on the historical and archaeological background, much work has already been done, and the resultant reports and publications have been listed in the reference section below. Their consultation will continue throughout the analyses and the publication stage.

6. Potential of the data

6. 1 Appraisal of site archive meeting research aims

The aims of the fieldwork were to investigate **1) the immediate to short-term human induced environmental consequences at Advent City** as well as **2) the medium- to long-term impact of the company town and mining activities after approximately one century of site abandonment**. It does so on the basis of animal and plant remains. Some of the animal and plant species occurred locally while others were intentionally or unintentionally brought to the site.

The excavation trenches were specially positioned to target the most promising archaeological deposits, in this case previously identified middens and a domestic refuse dump. The systematic collection of animal bones, plant remains, and soil samples yielded much useful environmental information, visual inspection of which already goes a long way to answering the above questions.

The state of preservation of all materials recovered under Arctic conditions is exceptional, and it lends itself to thorough palynological, zooarchaeological, and palaeobotanical analyses.

At the time of writing, it is thought that the site archive, especially in combination with the vegetation survey that has not been treated in this report, will meet the research aims almost in full. Parasites and diseases may still be difficult to prove, and the quantification of different environmental consequences may be tricky. Yet it will be possible to discern the nature of anthropogenic impact on a basis of presence and absence.

6.2 Statement of data developing new research aims

In the text, two possible avenues have already found mention:

1. It may be possible to investigate the chemical composition of food containers in view of possible detrimental effects, e.g. harmful lead concentrations in tin cans. This would further research into polar human health.
2. It may also be possible to investigate the bones of different animal species using radiocarbon (C^{14}) dating and complementary isotopic analysis. Seeing that time of death of the animals will have been between 1905 and 1908 (depending on the deposit), any discrepancy in the dating may be used to test the marine reservoir

effect at this location. This would further the correction of radiocarbon dates in a maritime Arctic context.

6.3 Potential of local to international importance

Although varied (topographic survey, 3D photogrammetry, archaeological excavation, and vegetation survey), the fieldwork at Advent City in August 2016 was kept intentionally small and treated as a pilot study. On the one hand, Arctic fieldwork is expensive (and dangerous). On the other hand, this project was able to test the **untapped archaeological potential** of the site and campaigns for **the timely shift in research direction from limited and selective industrial archaeology and/or mining history to overarching and inclusive historical ecology**, using cutting-edge archaeological sciences as an essential part of an interdisciplinary toolkit.

At local level, the archaeological fieldwork in the first instance challenged the common misconception that 'everything has already been done' at early mining settlements like Advent City, Longyearbyen, Ny Ålesund, Barentsburg, and Svea (and most other archaeological sites in Svalbard, for that matter!). Whilst pressing mining-related questions have in all probability been addressed, it remains largely unknown what the early and lasting environmental consequences of these places were. At *live* settlements like Longyearbyen, Ny Ålesund, and Barentsburg, these impacts have now been masked by ongoing and increasing human presence. Advent City is therefore doubly important as a place where we clearly see a beginning and an end to the activities, thus all environmental information is more or less preserved – if we can find the relevant deposits.

Advent City represents a very rare material experience of a bygone industrial age, not just in Svalbard but in Europe as a whole. The wealth of its cultural heritage continues to be undervalued and is at risk of disappearing all together. **The authors highly recommend that artefacts of this bygone age be rescued from inaccessible sites around Svalbard, conserved, and placed either at the Svalbard Museum or at roomier facilities like Mine No. 3.** The ropeway carriage at Advent City and the vertical gas engine at Hiorthhamn have been named. Kruse, in particular, has extensive experience of industrial heritage in Svalbard and can point out quite a few more. It is time to act before increasing rainfall coupled with increased microbial activity erodes these treasures forever.

As for the new-found environmental evidence from Advent City is concerned: **Svalbard's suitability to study the human impact on the Arctic ecosystems is probably unequalled**. This is due to the fact that there have been no indigenous people and that the islands were discovered fairly late in European history. Historical processes and their impacts can be studied using both well-preserved archaeological remains and exceptional historical documents. In this, Svalbard is arguable of global significance.

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